

New and rare micro-pagurid hermit crabs (Crustacea: Anomura: Paguridae) from the Caribbean Sea and Gulf of Mexico

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Abstract

Six species of hermit crabs of the family Paguridae from the Caribbean Sea and Gulf of Mexico region, including two new species, *Anisopagurus asteriscus* sp. nov. and *Pagurus alarius* sp. nov., are documented. The two new species are described, and recognition characters summarized for the four previously known species. Reports of the latter, *Nematopaguroides fagei* Forest & de Saint Laurent, 1968, *N. karukera* Lemaitre, Felder & Poupin, 2017, *Paguriscus robustus* Lemaitre, Felder & Poupin, 2017, and *Pylopaguridium markhami* McLaughlin & Lemaitre, 2001, represent range extensions for all four species. Color photographs are included for four of the species, as well as remarks on their taxonomy and distributions. All six species included can be categorized as micro-pagurids (with shield length rarely exceeding 2.0 mm), and were collected from cryptic reef habitats in Bocas del Toro, Panama; the French Antillean island of Guadeloupe; and the Gulf of Mexico coasts of Louisiana, Yucatán, and Florida Keys. The discovery of these new or rare species supports the conclusion of recent studies that the diversity of pagurids from the Caribbean region has yet to be fully realized.

Key words: Crustacea, Paguridae, micro-pagurids, new species, Caribbean Sea, Gulf of Mexico

Introduction

In a recent study of hermit crabs of the family Paguridae obtained from biodiversity investigations of coral reefs in the Caribbean Sea Lesser Antilles, Lemaitre *et al.* (2017) documented the existence of previously unsuspected diversity of this family of decapod crustaceans. The pagurids described or discussed in that study were strikingly diminutive in size (*i.e.*, typically with a shield length of 1.5 mm or less), for which the term “micro-pagurid” was used. That study added six new genera and eight new species to the Caribbean pagurid fauna. The specimens used in that study were collected in cryptic reef habitats during the KARUBENTHOS expeditions in Guadeloupe (Poupin & Corbari 2016) and the Smithsonian Institution’s Deep Reef Observation Program in Curaçao and Dominica (Baldwin *et al.* 2018); or recovered in Curaçao from specialized Artificial Monitoring Reef Structures or ARMS (Leray & Knowlton 2015), a sampling device that attracts minute mobile fauna that otherwise remains unseen or difficult to sample. In their study, Lemaitre *et al.* (2017) concluded that pagurid diversity and their distribution in the Caribbean Sea may be underestimated or poorly known as many cryptic habitats have been insufficiently sampled.

Additional micro-pagurid samples have now become available from recent detailed field work conducted by scientists from the Florida Museum of Natural History, University of Florida, in Bocas del Toro, Caribbean coast of Panama, and St. Martin, French Lesser Antilles. Continuing studies by teams from the Smithsonian Institution’s Deep Reef Observation Program in Curaçao have also obtained more micro-pagurids. The study of all this material, together with incompletely studied or questionably identified museum specimens collected in the Caribbean and Gulf of Mexico, has revealed the existence of yet two more undescribed micro-pagurids from the Caribbean region, as well as the presence of four rare pagurids previously known only from the types used in the original descriptions. The discovery of these specimens in other areas of the Caribbean Sea and Gulf of Mexico highlights once again the need to investigate in more detail the diversity of pagurids from this vast habitat-rich region. Herein the two new species are fully described and illustrated, and the recognition characters and taxonomy of the four previously

known species are discussed and also illustrated. At the time of the preparation of this study, the DNA barcode or sequence data had not yet been performed by the museum teams that collected and own the newly obtained materials. The genetic data will be made available in a public database when that analyses can be completed.

Material and methods

Specimens that prompted this report were provided by the Florida Museum of Natural History, University of Florida, Gainesville (UF), and obtained during the Smithsonian Institution's Deep Reef Observation Program (DROP). Supplemental specimens used remain deposited in the collections of Harbor Branch Oceanographic Institute at Florida Atlantic University (HBOI, formerly Indian River Coastal Zone Museum); Muséum national d'Histoire naturelle, Paris (MNHN); and National Museum of Natural History, Smithsonian Institution, Washington D.C. (USNM). The crustacean collection of the University of Louisiana at Lafayette Zoological Collections (ULLZ) has now been transferred to the USNM, and for that reason, specimens from the former collection are listed with their original ULLZ catalog number.

Morphological terminology is according to that used in the micro-pagurid study by Lemaitre *et al.* (2017). The ambulatory legs are equivalent to pereopods 2 and 3. Cephalothoracic somites and their sternites are numbered I–XIII (five cephalic and eight thoracic). Measurements or range of size indicated after each number of specimens in the material examined sections, refer to cephalothoracic shield length, measured from the tip of the rostrum to the midpoint of the posterior margin of the shield. Field numbers are indicated with the prefix BBDT or BSTM, and stations with the prefix BDT or STM for Bocas del Toro, Panama or St. Martin, French Antilles, respectively. Other abbreviations used: coll(s), collector (s); imm, immature; sta, station; and, ov, ovigerous. Months are abbreviated using the first three letters of the month. Depth data found in original data in feet has been converted to meters. The species are ordered alphabetically in the Systematics section.

Taxonomy

Family Paguridae Latreille, 1802

Anisopagurus asteriscus sp. nov.

(Figs 1–4)

Type material. Holotype: male 3.7 mm, St. Martin, French Antilles, Caribbean Sea, BSTM-1144, STM-044, 18.118°N, 63.056°W, 1.5–6.1 m, reef at night, 19 Apr 2012, colls G. Paulay, J. Slapcinsky, A. Bemis (UF 032279).

Paratypes: St. Martin, French Antilles, Caribbean Sea: 1 ov female 1.6 mm, Passe Espagnole, BSTM-0233, STM-011, 18.13°N, 63.005°W, 1.5–6.1 m 10.7–13.7 m, canyon with sponges, 11 Apr 2012, colls G. Paulay, J. Slapcinsky, A. Bemis (UF 031910); 1 female 1.4 mm, Circus, off Tintamarre Island, BSTM-1140, STM-040, 18.118°N, 63.056°W, 12.2–18.3 m, reef, 19 Apr 2012, colls G. Paulay, J. Slapcinsky, A. Bemis (UF 032275).

Guadeloupe: 3 males 0.7–1.0 mm, KARUBENTHOS 2012, Petite Terre, GB 31, 16°09.71'N, 61°07.73'W, 15 m, 26 May 2012, photographed by D.L. Felder (MNHN-IU-2013-5472).

Bocas del Toro Province, Panama, Caribbean Sea: 1 male 1.8 mm, Punta Puebla, 9.367°N, 82.291°W, BBDT-0606, BCS2016-012, [no depth], 16 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044312); 1 male 1.9 mm, same data as previous, BBDT-0607, BCS2016-012; 1 female 2.1 mm, Seagal, 9.289°N, 82.296°W, BBDT-2888, BCS2016-043, 3–3.5 m, lagoon fringing reef, *Agaricia* reef framework, 27 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 052159); 1 female 2.1 mm, runway, 9.342°N, 82.260°W, BBDT-2089, BCS2016-034, [no depth], 23 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044440); 1 male 1.8 mm, 1 female 1.5 mm, Popa Reef, 9.233°N, 82.112°W, BBDT-2423, BCS2016-036, [no depth], 24 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044486).

Description. Shield (Fig. 1A) subtriangular, terminating in sharp spine, approximately 1.2 times as long as broad; dorsal surface glabrous, lacking linea or grooves except for weakly visible short linea-d and grooves separating narrow lateral lobe on each side; anterior margin between rostrum and lateral projections concave; anterolateral

margins sloping; posterior margin roundly truncate. Rostrum acutely triangular, reaching distally beyond lateral projections. Lateral projections subtriangular, terminating in sharp spine.

Ocular peduncles relatively long, about 0.7 length of shield, weakly diminishing in length distally; dorsal surfaces nearly naked or at most with short setae medially and dorsodistally; corneas weakly dilated. Ocular acicles subtriangular, terminating in 2 or 3 sharp spines.

Antennular peduncles exceeding distal margins of cornea when fully extended by approximately one-third length of ultimate segment. Segments naked or with scattered short setae; basal segment with blunt ventromesial distal angle, and small spine on lateral face.

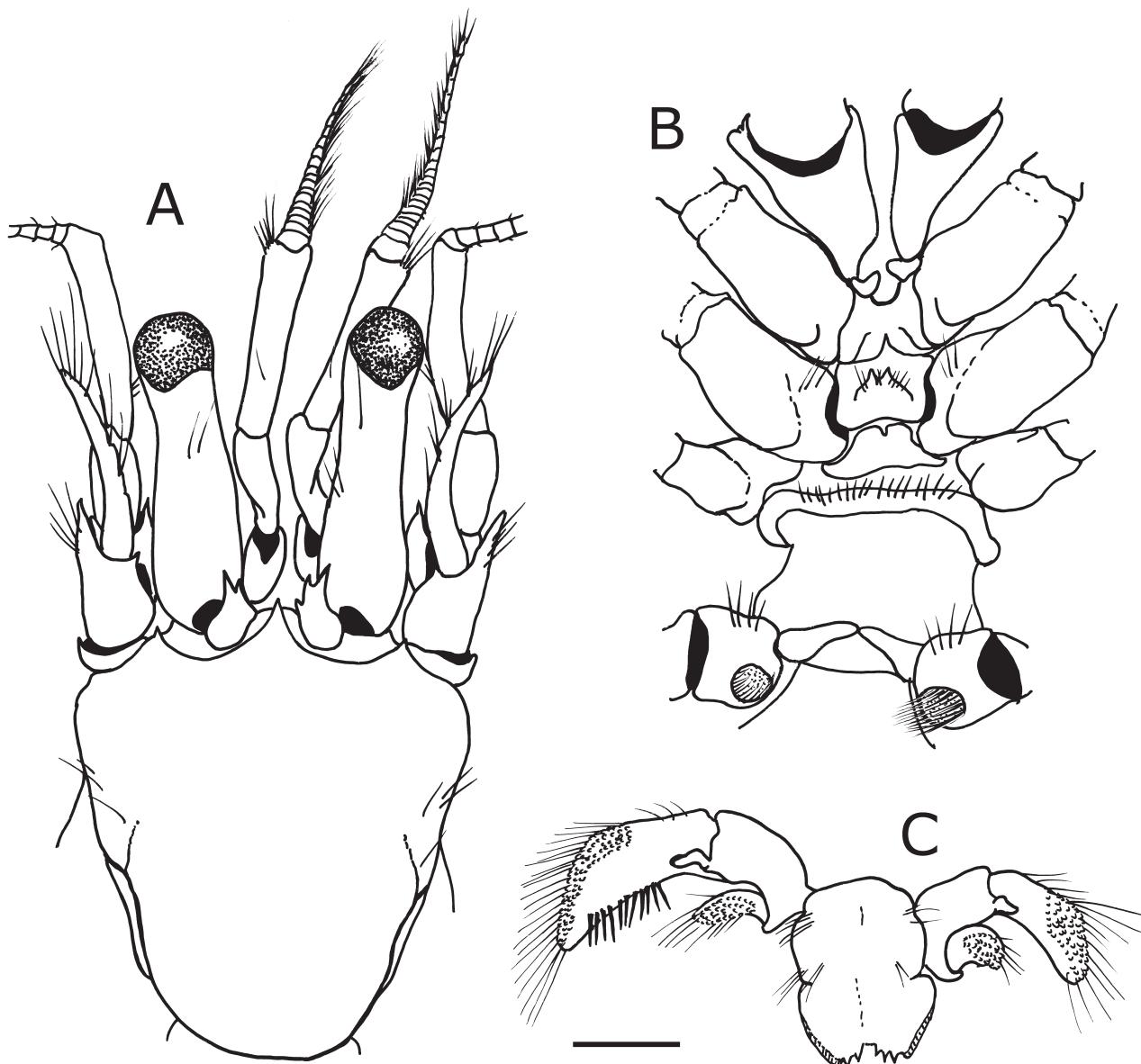


FIGURE 1. *Anisopagurus asteriscus* sp. nov., holotype male 3.7 mm, St. Martin, French Antilles, Caribbean Sea (UF 032279): A, shield and cephalic appendages, dorsal; B, sternum and coxae of pereopods 1–5, ventral; C, uropods and telson, dorsal. Scale: 0.5 mm.

Antennal peduncles, when fully extended, exceeding distal margins of corneas by approximately half of fifth segment. Fifth segment slender, approximately 6 times as long as wide, unarmed except for scattered short setae. Fourth segment unarmed except for scattered short setae. Third segment with spine on ventrodistal angle. Second segment with dorsolateral distal angle produced into strong spine-like process with short laterodistal setae; dorsomesial distal angle with small spine. First segment with small lateral spine. Antennal acicles not exceeding distal margins of corneas, broadly curving outward, terminating in strong spine, with few tufts of setae on mesial margin and tuft of setae distally. Flagellum long, exceeding extended right cheliped, with few short setae 1 or less flagellar article in length.

Mouthparts not dissected. Third maxilliped ischium with crista dentata consisting of approximately 14 small teeth slightly diminishing in length distally, and accessory tooth.

Chelipeds strongly dissimilar in strength and shape, right distinctly larger and stronger than left. Right cheliped (Fig. 2A–C) suboperculate. Chela ovate, approximately 1.8 times as long as broad; angle of articulation with carpus 90° or larger (viewed laterally); dorsal surface of palm and fingers surrounded by strong, corneous-tipped spines interspersed with long setae and directed nearly vertically forming crown-like shape; dactyl and fixed finger each terminating in inwardly curved blunt calcareous tips overlapping when closed; ventral surface glabrous except for scattered tufts of long setae. Dactyl about as long as palm; dorsal surface with low star-like tubercles bearing short bristle-like setae, and tufts of bristle-like setae near cutting edge and directed toward cutting edge of fixed finger; cutting edge with 8 strong, rounded calcareous teeth slightly diminishing in strength distally. Fixed finger armed on dorsal surface with a few strong spines basally, and tufts of bristle-like setae near cutting edge directed toward cutting edge of dactyl; cutting edge with 7 unequal calcareous teeth, middle tooth distinctly larger than others. Palm slightly longer than broad, with median region moderately elevated, armed with cluster of strong, corneous-tipped spines and surrounded by more or less flat surface covered with numerous low flat-topped, well-spaced star-like tubercles (Fig. 2A, C) that extend to fixed finger; proximal dorsal surface strongly sloping towards articulation with carpus. Carpus approximately as long as merus; dorsal surface with scattered tufts of setae and dorsomesial row of 4 corneous-tipped spines; dorsodistal margin with 1 small subdistal spine; ventral surface glabrous except for few tufts of setae; mesial surface nearly vertical, glabrous; lateral surface rounded; ventral surface glabrous, bulging proximally. Merus subtriangular in cross-section, naked or sparsely setose; dorsodistal margin armed with small median spine; ventrodistal margin with row of 4 small spines distally and row of long setae, ventromesial margin unarmed or with 1 small spines and row of long setae. Ischium unarmed. Coxa with row of setae on ventromesial distal angle.

Left cheliped (Fig. 2E, F) slender, approximately as long as right cheliped; fingers terminating in inwardly curved corneous tips crossed when closed, ventrodistal surface spoon-like. Dactyl slightly longer than palm, with low setose tubercles on dorsal surface; cutting edge with row of fused minute corneous spinules; lateral margin with long setae; ventral surfaces glabrous. Fixed finger with few tubercles and setae on dorsal surface, and row dorsolateral row of small tubercles on distal three-fourths; cutting edge with row of minute calcareous teeth and row of fused corneous spinules distally. Palm dorsolateral margin with prominent row of strong, corneous-tipped spines directed dorsolaterally with tips slightly curving forward and interspersed with long setae, row of spines continued to basal portion of fixed finger and diminishing slightly in size; dorsal surface with distinct median irregular row of prominent slender corneous-tipped spines; mesial surface rounded, with few low tubercles and scattered setae; ventral surface glabrous except for a scattered tufts of long setae. Carpus approximately as long as merus; dorsal surface with 2 rows of spines, and strong spine on dorsodistal margin; lateral and mesial surfaces glabrous; ventral surface unarmed; ventrodistal margin with small tubercles and 1 small spine laterally. Merus subtriangular in cross-section; dorsal margin with minute tubercles and short setae; lateral and mesial faces glabrous; ventrolateral margin with long setae and row of 4 strong spines, ventromesial margin with row of small tubercles and 1 distal spine. Ischium and coxa unarmed, latter with row of setae on ventromesial margin.

Pereopods 2 and 3 (Fig. 3A–D) sparsely setose, subequal left from right. Dactyl approximately as long as propodus, with few setae dorsally and scattered short setae ventrally; ventral margin nearly straight, dorsal margin broadly curved, terminating in sharp corneous claw curving ventrally; ventromesial margin with row of 6 or 7 distinct corneous spinules. Propodus nearly straight, approximately 1.3 times times as long as carpus, with few setae dorsally and well-spaced tufts of short setae ventrally; lacking spines except for 1 or 2 corneous spinules on ventrodistal angle. Carpus with small dorsodistal calcareous spine. Merus unarmed, with few tufts of setae dorsally and ventrally. Ischium unarmed. Anterior lobe of sternite XI (of pereopods 3; Fig. 1B) subcircular, sparsely setose and armed with 2 small spines distally.

Pereopod 4 (Fig. 3E, F) semichelate. Dactyl nearly straight, slender, terminating in short, inwardly directed corneous claw; dorsal margin with long setae distally; ventral margin with short brush-like preungual process (Fig. 3F) at base of corneous claw, and row of short close-set corneous teeth. Propodal rasp with 2 or 3 rows of ovate corneous scales. Carpus unarmed except for few setae dorsally. Merus unarmed except for dorsodistal tuft of long setae.

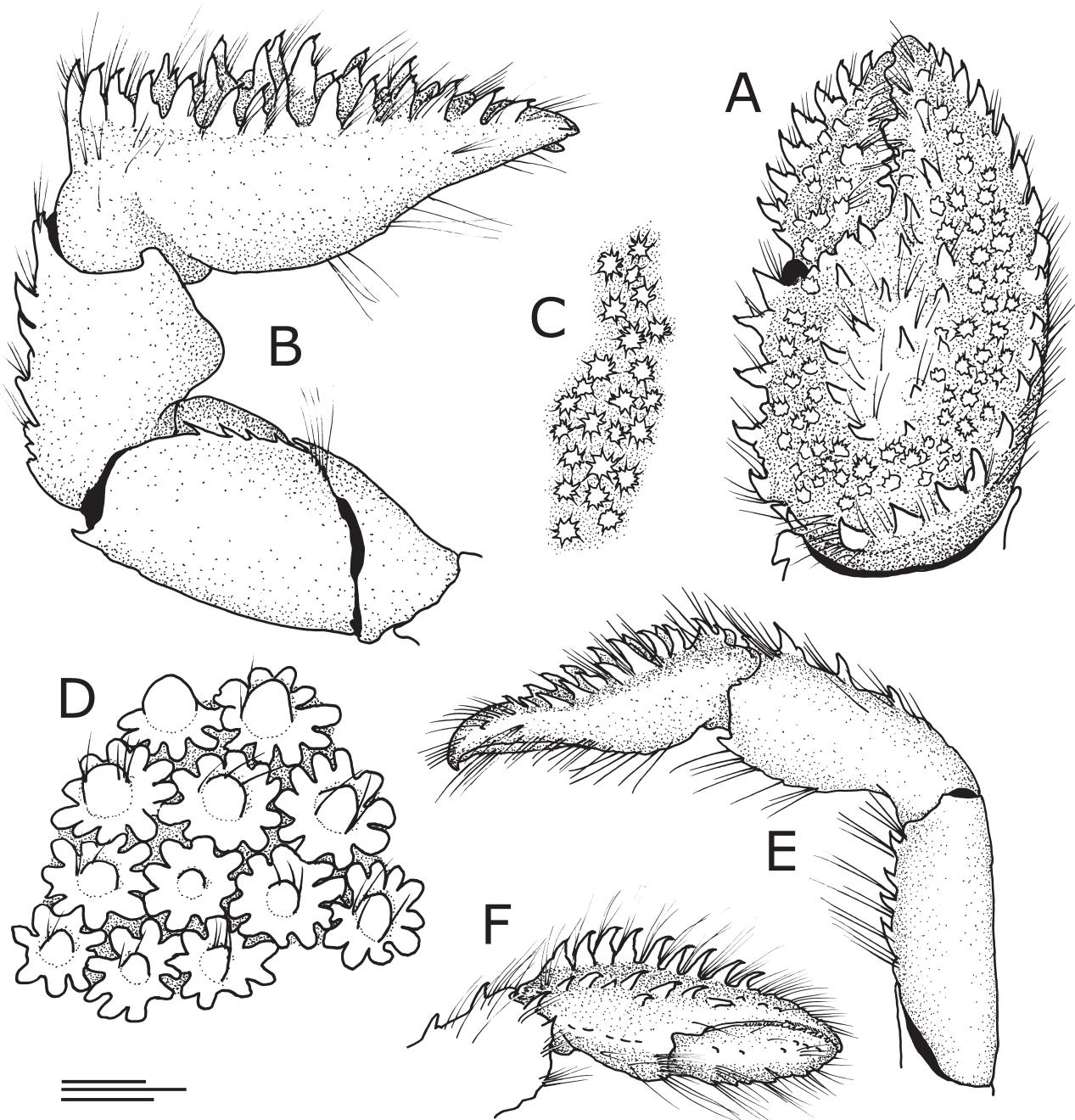


FIGURE 2. A–C, E, F, *Anisopagurus asteriscus* sp. nov., holotype male 3.7 mm, St. Martin, French Antilles, Caribbean Sea (UF 032279); D, *Rhodochirus rosaceus* (A. Milne-Edwards & Bouvier, 1893), SE Caribbean Sea, R/V Pillsbury, sta P-479, 11°19'42"N, 62°01'12"W, 121–131 m, 3 Aug 1966 (USNM 267504). A, right chela, dorsal; B, right cheliped, lateral; C, portion of dorsal surface of palm showing star-like tubercles; D, portion of dorsal surface of palm showing rosette-like tubercles; E, left cheliped, lateral; F, chela of same dorsomesial. Scales: 0.5 mm.

Pereopod 5 chelate. Propodal rasp dorsally extending for about 0.3 length of propodal surface. Coxae of males asymmetrical, left larger than right and with gonopore covered by dense short setae directed mesially; right gonopore also having setae but distinctly shorter and less dense than on right gonopore. Coxa a females symmetrical.

Uropods (Fig. 1C) markedly asymmetrical, left largest, exopods each with row of long setae dorsally; ventral margin of left exopod with distinct fringe of long corneous bristles, ventral margin of right exopod naked. Telson (Fig. 1C) nearly symmetrical, longer than broad, with distinct lateral indentations; posterior lobes with corneous lateral margins, lobes separated by U-shaped median cleft, terminal margins weakly oblique, each armed with row of 3 small spines in addition to acute laterodistal angle.

Males with paired gonopores, lacking sexual tubes (Fig. 1B); with unpaired left biramous pleopods 3–5. Females with paired gonopores; with unpaired left pleopods 2–5 (pleopod 5 non-ovigerous); only available ovigerous female (shield length = 1.6 mm, UF 031910) carrying relatively few (21) large eggs ~0.6 mm in diameter.

Color (Fig. 4). Shield with unevenly light yellow and brown portions. Ocular peduncles whitish with brown stripes dorsolaterally and dorsomesially; corneas white with reddish blotches. Antennular and antennal peduncles semitransparent distally, light brown proximally; antennal flagella dark red with about 8 short white bands. Right cheliped reddish, with chela somewhat faded. Left cheliped brownish, with spines on chela faded red. Pereopods 2 and 3 (ambulatory legs) brownish similar to left cheliped, with short white portions nearer articulations of meri-carpi and distal portion of propodi; dactyls faded brownish.

Etymology. The specific name is derived from the Greek *asteriskos*, meaning small star, and refers to the characteristic minute star-like tubercles that adorn the dorsal surface of the right chela of this new species.

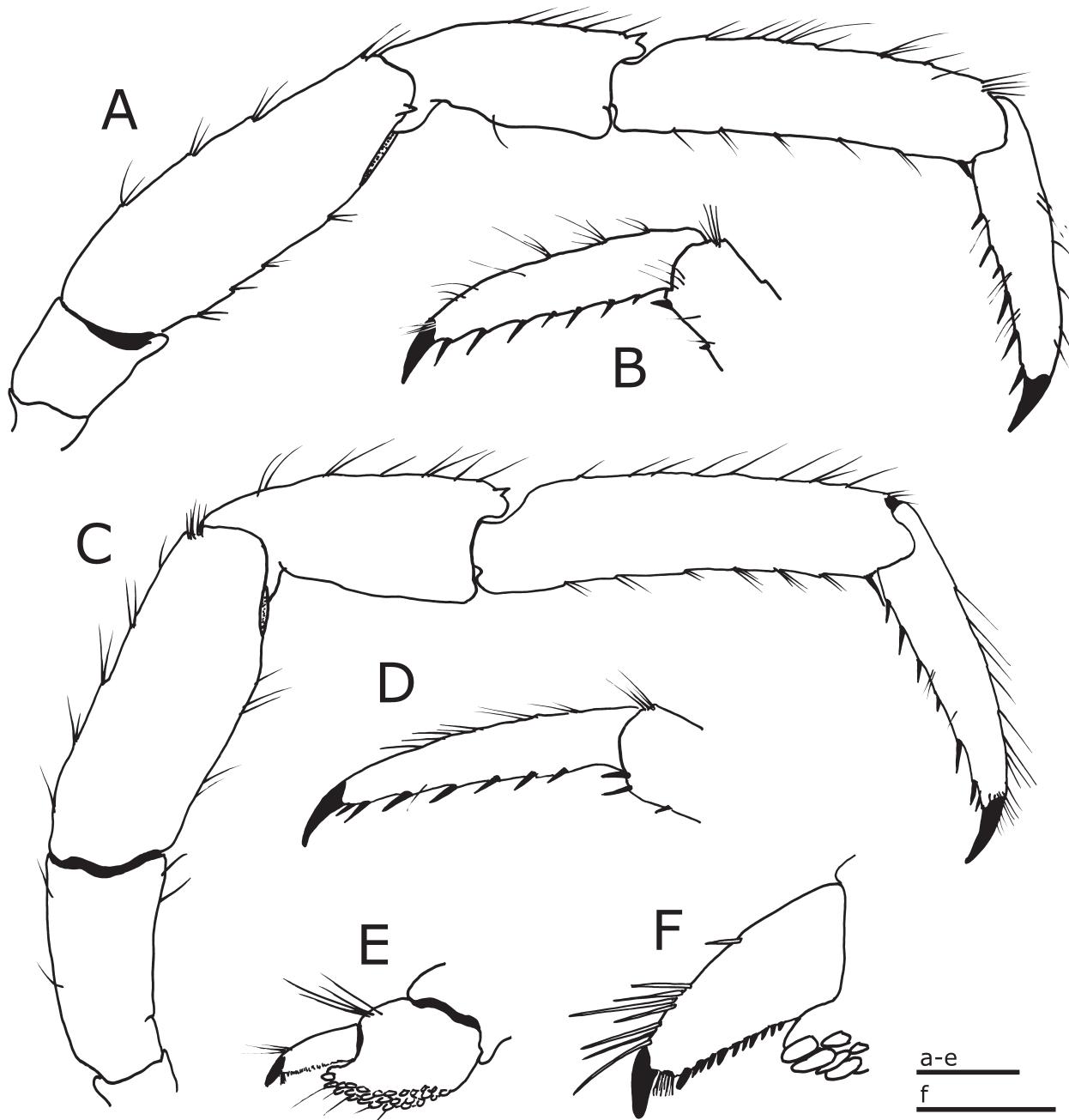


FIGURE 3. *Anisopagurus asteriscus* sp. nov., holotype male 3.7 mm, St. Martin, French Antilles, Caribbean Sea (UF 032279): A, right pereopod 2, lateral; B, dactyl of same, mesial; C, right pereopod 3, lateral; D, dactyl of same, mesial; E, propodus and dactyl of pereopod 4, lateral; F, dactyl of same, lateral. Scales: 0.5 mm (A–E), 0.25 mm (F).

Distribution. Caribbean Sea, known so far from St. Martin, French Antilles, and Bocas del Toro Province, Panama. Depth: 1.5–18 m.

Remarks. *Anisopagurus asteriscus* sp. nov. and *A. pygmaeus* are the only species of *Anisopagurus* having multispinose ocular acicles and a fringe of long bristle-like setae on the posterior margin of the exopod of the left uropod. In other respects, however, these two species differ significantly. In the new species the right chela (Fig. 2A–C) is markedly operculate in shape, with the dorsal surface of the palm crowned with strong, corneous-tipped marginal spines directed upwardly, and the surface is covered with numerous well-spaced star-like tubercles; whereas in *A. pygmaeus*, the right chela is not operculate, and is armed dorsally with only simple often strong spines. Furthermore, males of the new species have asymmetrical coxae, the left being larger and with a gonopore covered by more dense and longer setae directed mesially, whereas the coxae and setation are symmetrical in *A. pygmaeus*. The presence in males of this new species of asymmetrical coxae of the fifth pereopods might suggest a relationship with another species in the *Pylopagurus* group of genera, *Pylopaguridium markhami* McLaughlin & Lemaitre, 2001. Asymmetrical coxae of the fifth pereopods is considered a generic character of *Pylopaguridium*. However, *A. asteriscus* sp. nov. and *P. markhami* differ in other generic as well as species characters. Particularly distinct in these two species are color differences in pereopods 2 and 3 (ambulatory legs), in the former the segments being brownish with short white portions near the articulations of the meri, carpi and propodi, and light brown dactyls (Fig. 4), whereas in the latter the segments are tricolored orange-white-blue (in two tones) and bicolored orange-white dactyls (see Poupin 2018: 161, fig. 164).

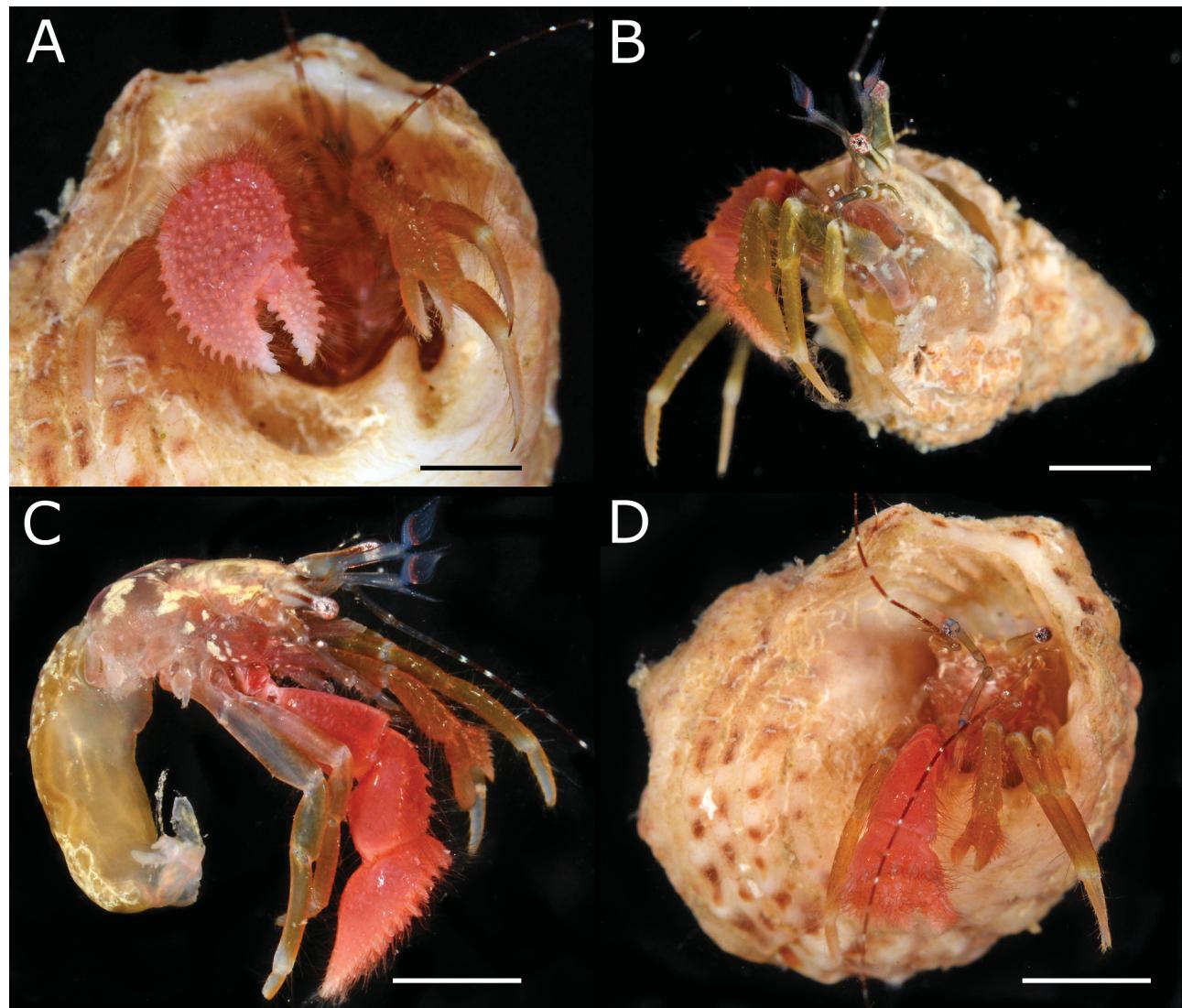


FIGURE 4. *Anisopagurus asteriscus* sp. nov., Bocas del Toro Province, Panama, Caribbean Sea: A, B, female (in shell) 2.1 mm (UF 044440); C, male 1.8 mm, removed from shell (UF 044486); D, same male in shell (UF 044312). Scales: 2.0 mm. (Photographs: G. Paulay).

Anisopagurus asteriscus sp. nov. differs most distinctly from the other five species of *Anisopagurus* by the armature of the chelipeds, in particular the right cheliped. In *A. asteriscus* sp. nov., the dorsal surface of the right chela bears numerous low star-like tubercles, whereas these type of tubercles are absent in other congeners.

The armature of the dorsal surface of the right chela in *A. asteriscus* sp. nov. might, at first examination, be confused with that exhibited by *Rhodochirus rosaceus* (A. Milne-Edwards & Bouvier, 1893), a species belonging in another of the “*Pylopagurus*” group of genera (Lemaitre & McLaughlin 2003). In *Anisopagurus asteriscus* sp. nov., however, the dorsal surface of the right chela is in part covered with numerous flat-topped, well-spaced low star-like tubercles, whereas in species of *Rhodochirus* the same surface is covered with tightly clustered or even partially fused sharp to blunt tubercles or spines with rosette-like bases (Fig. 2D; McLaughlin 1981). Further differentiating these two species is that in *Anisopagurus asteriscus* sp. nov. the dorsal surface of the left chela bears only spines and lacks any tubercles similar to those on the right chela, whereas in *Rhodochirus* species, the left chela has a similar rosette-like armature to that of the right chela.

Nematopaguroides fagei Forest & de Saint Laurent, 1968

(Figs 5, 6)

Nematopaguroides fagei Forest & de Saint Laurent, 1968: 157, figs 136–141 (type locality: off Recife, Brazil, *Calypso*, sta 27, 8°25.5'S, 34°48.5'W); Coelho & Ramos, 1973: 166 (list); Coelho & Santos, 1980: 143 (list); Coelho & Ramos-Porto, 1986: 43 (list); Rieger, 1998: 417 (list); Wang & McLaughlin, 2000: 956; McLaughlin, 2003: 124; McLaughlin *et al.*, 2010: 31; Lemaitre & Tavares, 2015: 492; Coelho *et al.*, 2007: 10, tab. 4; Lemaitre *et al.*, 2017: 164.

Nematopaguroides cf. *fagei*.—Baker *et al.*, 1981: 355, tab. G4; Felder *et al.*, 2009: 1070 (in part, see Remarks).

Not *Nematopaguroides* cf. *fagei* (= *N. karukera* Lemaitre, Felder & Poupin, 2017).—Gore, 1981: 159.

Material examined. *Gulf of Mexico*: 1 male 1.2 mm, 1 ovig female 1.1 mm, EPA DYNACORP PROJECT, EPA 54763 264-repA, South Marsh Island 57C, platform #2, [south of Grand Isle, Louisiana], 40 m, [no date], coll R.W. Heard (USNM 1253305); 1 male 1.5 mm, R/V *Pelican*, NSF-II-060, DEB-0315995, 21°34.18'N, 91°4.71'W, 33 m, sand/rubble, box dredge, 12 Jun 2005, coll D.L. Felder *et al.* (USNM 1541790, ex ULLZ 6992); 1 male 0.8 mm, R/V *Pelican*, station NSF-II-098, southwest Gulf of Mexico, 22°6.91'N 91°20.74'W, 42–41 m, 17 Jun 2005, gear box dredge, rubble, coll D.L. Felder *et al.* (USNM 14655083, ex ULLZ 7072).

Guadeloupe, French Antilles, Caribbean Sea: KARUBENTHOS 2012: 2 ov females 1.0, 1.1 mm, GS 10, 16°03.25'N, 61°46.17'W, 23 m, 9 May 2012, vieux habitant-herbier à *Halophila stipulacea*, MNHN-IU-2013-5469; female 0.6 mm, GD 11, 16°07.72'N, 61°46.26'W, 14 m, 9 May 2012 anse à la barque-herbier à *Halophila stipulacea* (MNHN-IU-2013-5613); 1 male 1.0 mm, 1 ov female 1.1 mm (MNHN-IU-2013-5607), 2 males 1.2, 1.5 mm (MNHN-IU-2013-5308), GD 21, Pointe sur baie de Baille-Argent, 16°15.55'N, 61°48.8'W, 40 m, 12 May 2012.

Recognition characters. Shield (Fig. 5A) as broad as long, dorsal surface smooth. Rostrum broadly rounded. Ocular peduncles shorter than shield length, dorsal surface with short, stiff setae, corneas weakly dilated; acicles terminating bluntly and with small submarginal spines. Chelipeds (Fig. 5B, C) sparsely setose, not much different in length, right stouter, fingers of left reaching to approximately midline of fingers of right; palm of right cheliped with dorsolateral and dorsomesial margins armed with row of small spines; carpi of right and left with distinct dorsolateral and dorsomesial row of spines. Pereopods 2 and 3 (Fig. 6A–D) with long setae mostly on dorsal and ventral margins; dactyls broadly curved, approximately 1.1 times as long as propodus, with ventromesial row of 3–6 slender corneous spinules. Propodal rasp of pereopod 4 (Fig. 6E) with single row of rounded scales. Telson (Fig. 6F) posterior lobes asymmetrical, separated by deep median U-shaped cleft, terminal margins each armed with 2 or 3 spines in addition to more prominent ventrally curved spine at lateral angle. Male with unpaired right sexual tube on coxa of fifth pereopod (Fig. 5D), tube coiled and distally filiform. Ovigerous female carrying relatively few (usually 10–15) eggs.

Color. Unknown.

Distribution. Gulf of Mexico, from Louisiana and off Yucatán; Caribbean Sea Lesser Antilles, from Guadeloupe; and States of Pernambuco and Bahia, Brazil. Depth: 14–41 m.

Remarks. This is the type species of *Nematopaguroides* Forest & de Saint Laurent, 1968. Since Forest & de Saint Laurent's (1968) description of *N. fagei*, this rare species has been mentioned in biogeographical studies of

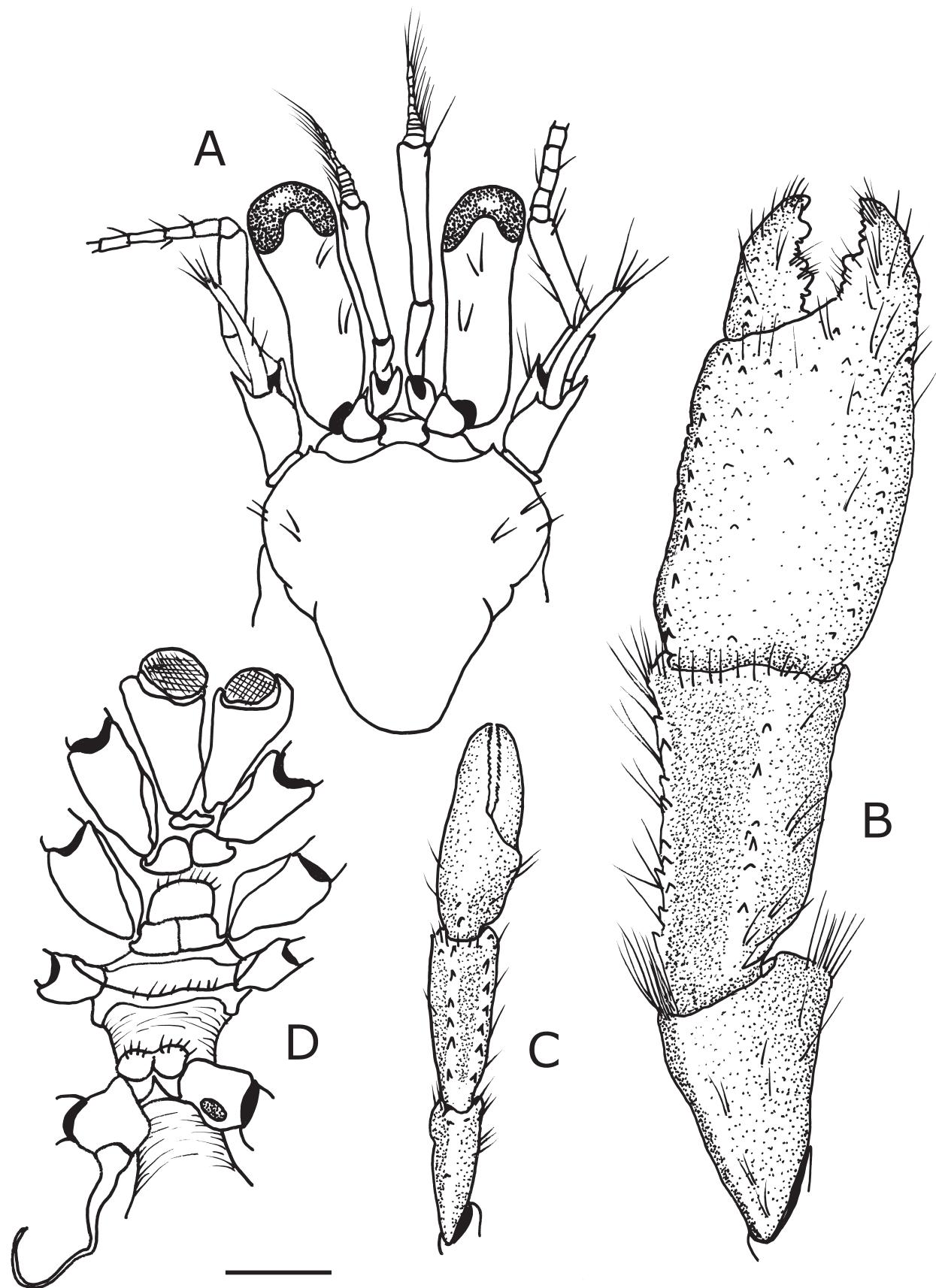


FIGURE 5. *Nematopaguroides fagei* Forest & de Saint Laurent, 1968, male 1.5 mm, KARUBENTHOS 2012, sta GD 21, Pointe sur baie de Baille-Argent, Guadeloupe, French Antilles, Caribbean Sea (MNHN-IU-2013-5308): A, shield and cephalic appendages, dorsal; B, right cheliped, dorsal; C, left cheliped, dorsal; D, sternum, coxae of pereopods 1–5, and sexual tube, ventral. Scale: 0.5 mm.

the decapod fauna from Brazil (Coelho & Ramos 1973; Coelho & Santos 1980; Coelho & Ramos-Porto 1986; Coelho *et al.* 2007), although apparently no new material was collected in those studies and thus the distribution was based on the few type specimens from Pernambuco to Bahia, Brazil. Gore (1981) did report one juvenile from Key Largo, Florida, noting that because of its small size and juvenile condition could not be positively identified as this species, and thus was reported therein as *N. cf. fagei*. However, examination of Gore's material (formerly in the Indian River Coastal Zone Museum, HBOI 89:4699, currently under Florida Atlantic University oversight) has shown that it is an adult albeit minute male (shield length = 1.1 mm) of *N. karukera* Lemaitre, Felder & Poupin, 2017.

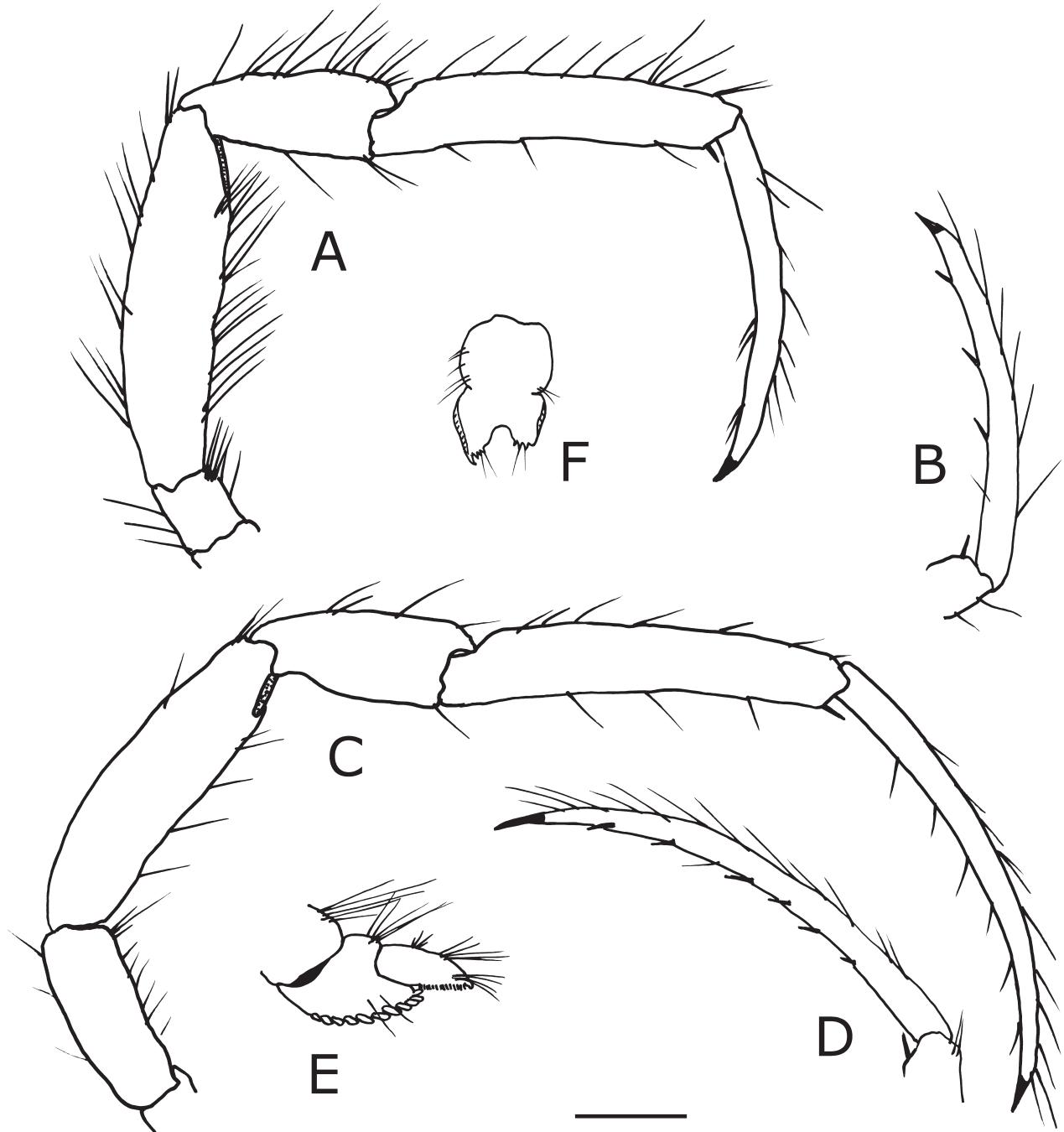


FIGURE 6. *Nematopaguroides fagei* Forest & de Saint Laurent, 1968, male 1.5 mm, KARUBENTHOS 2012, sta GD 21, Pointe sur baie de Baille-Argent, Guadeloupe, French Antilles, Caribbean Sea (MNHN-IU-2013-5308): A, left pereopod 2, lateral; B, dactyl of same, mesial; C, left pereopod 3, lateral; D, dactyl of same, mesial; E, propodus and dactyl of left pereopod 4, lateral; F, telson, dorsal. Scale: 0.5 mm.

Felder *et al.* (2009) tentatively included *Nematopaguroides fagei* (as *N. cf. fagei*) in the fauna from the Gulf of Mexico based on the equally tentative report by Gore (1981) but cited additional specimens they collected in

the northwestern Gulf of Mexico (cited in Baker *et al.* 1981). Felder *et al.* questioned whether the specimens from the Gulf actually represent *N. fagei*, a species until then known only from Brazil. However, a male and an ovigerous specimens (USNM 1253305) collected south of Grand Isle, Louisiana, have been studied and agree in most respects with Forest & de Saint Laurent's (1968) description of *Nematopaguroides fagei*, except that the Louisiana specimens have a right chela with a dorsal surface smooth, unarmed and nearly glabrous, whereas Forest & de Saint Laurent describe a right chela with dorsolateral, dorsomesial and medial rows of spines. This difference in armature may well represent intra-specific morphological variation of the type frequently seen on the right cheliped in other pagurids (e.g., Lemaitre *et al.* 1982). The morphology of two male specimens (USNM 1541790 ex ULLZ 6992, USNM 14655083, ex ULLZ 7072) collected in the southwest Gulf of Mexico, although the former is missing the ambulatory legs, and the latter is small in size (shield length = 0.8 mm), is consistent with the definition of *N. fagei* by Forest & de Saint Laurent (1968).

Nematopaguroides fagei can be differentiated from the other two western Atlantic congeners (*i.e.*, *N. pusillus* and *N. karukera*) by the armature of the carpus of the left cheliped (with a dorsolateral and dorsomesial row of spines on the carpus in *N. fagei* vs. with few weak spines or spineless in *N. pusillus* and *N. karukera*), and the shape and proportions of the dactyls of pereopods 2 and 3 (long and broadly curved in *N. fagei* vs. short and curved in *N. pusillus* and long and straight in *N. karukera*).

The specimens of *N. fagei* herein reported indicate a considerable range for this species, from the Gulf of Mexico and Caribbean Sea Lesser Antilles to Brazil. Based on the morphology of the few known specimens alone, and until more material can be collected throughout a broad geographic range to be analyzed using both comparative anatomy and DNA techniques, no other conclusion than this species having a broad distribution can be reached.

***Nematopaguroides karukera* Lemaitre, Felder & Poupin, 2017** (Fig. 7, 11B)

Nematopaguroides cf. *fagei*.—Gore, 1981: 159; Felder *et al.*, 2009: 1070 (in part, see Remarks under *N. fagei*).

Nematopaguroides karukera Lemaitre, Felder & Poupin, 2017: 160, figs 5–8, tab. 1 (type locality: off Deshaies, Guadeloupe, 16°17.51'N, 61°48.96'W); Poupin, 2018: 163.

Material examined. *Southeastern Gulf of Mexico*: 1 male 1.1 mm, Key Largo, Elbow Reef, Monroe County, Florida, R/V Johnson, JSL-I-690, 25°0.7.7'N, 80°15.9'W, 18.3 m, 7 Jun 1979, on relic *Montastrea* (HBOI 89:4699); 1 male 1.2 mm, Dry Tortugas, R/V Pelican, NSF-I-31, DEB-0315995, 24°48.6'N, 83°40.6'W, 66.6 m, [with] *Agaricia cca anadyomenae*, dredge, 2 Jun 2004, coll D.L. Felder *et al.* (USNM 14657559, ex ULLZ 8948).

Curaçao, Lesser Antilles, Caribbean Sea: 1 male 1.5 mm, ARM 26, E of downline at Substatioin Curaçao dock, Bapor Kibra, transect 2, 12°04'56.11, 68°53'50.51, 55 m, 10 Oct 2016, BCURA 2053 (USNM 1558025); 1 male 1.0 mm, ARM 27, 91 m, [same as previous], 10 Oct 2016 (USNM 1558026); 1 sex indet. [specimen incomplete] 0.7 mm, ARM 30, [same as previous], 55 m, 12 Oct 2016, BCURA 2456 (USNM 1558027); 1 ov female 0.9 mm (USNM 1558029), 1 male 1.1 mm (USNM 1558030), ARM 31, [same as previous], 91 m, 12 Oct 2016, BCURA 2554; 1 male 1.0 mm, USNM 1558034, 1 ov female 1.0 mm (USNM 1558035), ARM 56, [same as previous], 55 m, 15 Nov 2018.

Bocas del Toro Province, Panama, Caribbean Sea: 2 ov females 1.5, 1.8 mm, Ponsak, 9.294°N, 82.332°W, BBDT-0155, BCS2016-004, 3.0–3.5 m, lagoon fringing reef, *Agaricia* reef framework, 13 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044300); 1 male 1.0 mm, same as previous (UF 052160); 6 males 0.5–1.5 mm, 1 female 0.5 mm, 4 ov females 0.9–1.1 mm, runway, 9.342°N, 82.260°W, BBDT-1292, BCS2016-023, 4.0–4.5 m, lagoon fringing reef, *Agaricia* reef framework, 19 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044398); 1 ov female 1.5 mm, [same as previous] (UF 052161); 4 males 0.9–1.5 mm, 3 ov females 0.9–1.0 mm, Seagal, 9.289°N, 82.296°W, BBDT-2565, BCS2016-038, 4.0–4.5 m, lagoon fringing reef, *Agaricia* reef framework, 25 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044494).

Recognition characters. Shield as broad as long, dorsal surface smooth. Rostrum broadly rounded to obsolete. Ocular peduncles shorter than shield length, mesial surface of each with low knob bearing short, stiff setae, corneas moderately dilated; acicles terminating bluntly and with small submarginal spines. Chelipeds subequal in length, right stouter; palm or right cheliped with row small spines on dorsolateral and dorsomesial margins; palm of left cheliped with median, longitudinal row of minute. Pereopods 2 and 3 having well-spaced low knobs bearing long

setae on dorsal margins of meri, carpi and propodi; dactyls nearly straight, with ventromesial row of 5–7 long, slender corneous spinules. Propodal rasp of pereopod 4 with single row of rounded scales. Telson posterior lobes nearly symmetrical, separated by median V-shaped cleft, terminal margins each armed with 2 or 3 small spines in addition to more prominent ventrally curved at lateral angle. Male with paired, asymmetrical sexual tubes on coxae of fifth pereopods; left sexual tube long, often coiled and distally filiform, right sexual tube conical, not distally filiform. Ovigerous female usually carrying few relatively large eggs (usually 3–8 on each pleopod) approximately 0.3 mm in maximum width.

Color (Fig. 7, 11B). Shield unevenly colored in camouflage pattern with irregularly shaped white or yellowish-brown blotches or spots, and usually faded red tiny spots on distal half. Ocular peduncles light yellow with faded red tiny spots and oval or rounded white spots; corneas light pink with white-dotted external lens. Antennular and antennal peduncles semi-transparent with light brownish cuticle; antennal flagella brown with approximately 8 or 9 short white bands. Chelipeds colored more or less in camouflaged pattern, dorsal surface mostly light yellow with irregularly shaped light brownish portions. Pereopods 2 and 3 (ambulatory legs) light yellow, semi-transparent; with two poorly defined brownish bands speckled with small yellowish spots on each merus, carpus, and propodi; dactyls with uneven brownish bands interspersed with yellowish portions. Sternum and ventral faces of coxae whitish or semi-transparent, with small reddish spots or blotches.

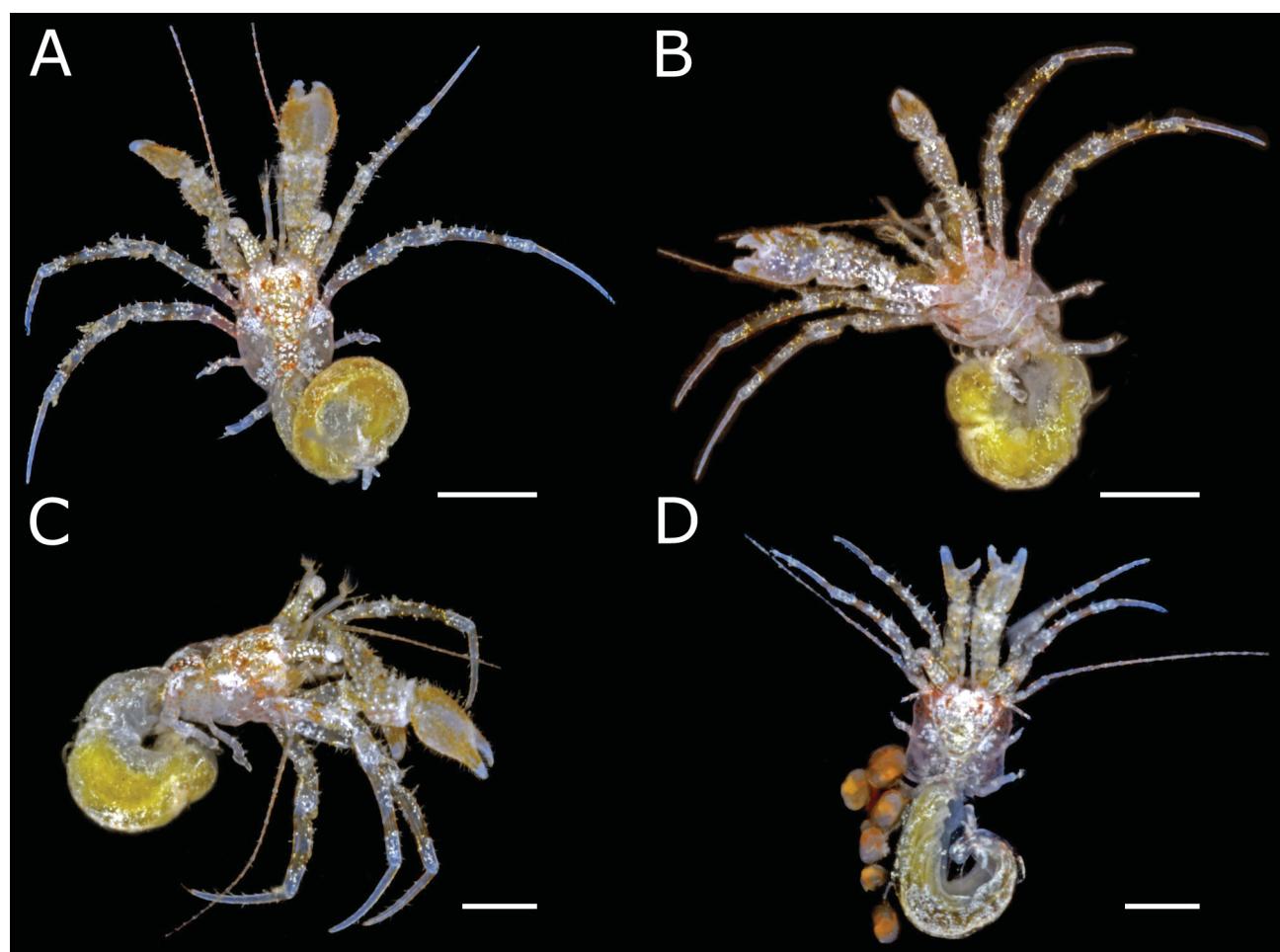


FIGURE 7. *Nematopaguroides karukera* Lemaitre, Felder & Poupin, 2017, Curaçao. A–C, male, 1.5 mm, Curaçao, ARM 26, BCURA 2053 USNM 1558025; D, ov female, 0.9 mm, ARM 31, BCURA 2554 (USNM 1558029): A, D, dorsal; B, ventral; C, lateral. Scales: 2.0 mmm (A, B), 1.0 mm (C, D). (Photographs: D.L. Felder)

Distribution. Southeastern Gulf of Mexico, from Florida Keys, from Key Largo and Dry Tortugas; Caribbean Sea, from Guadeloupe and Curaçao in Lesser Antilles, and Bocas del Toro, Panama. Depth: 1–91 m.

Remarks. This species was previously known based on the type specimens from Guadeloupe, on the eastern Caribbean Sea, Lesser Antilles (Lemaitre *et al.* 2017). The presence of *Nematopaguroides karukera* further south in Curaçao as well as in Bocas del Toro, Panama, on the southwestern Caribbean Sea, and the Florida Keys, in the

southeastern Gulf of Mexico, suggests that this species is broadly distributed in the Caribbean region. Affinities and differences with the two western Atlantic congeners, *N. fagei* and *N. pusillus*, are discussed in Lemaitre *et al.* (2017).

At the time of the discovery of *Nematopaguroides karukera* in the reefs of Guadeloupe, no color information or photographs were available to include in Lemaitre *et al.*'s (2017) description of this species. Herein, the description of the color pattern of this species is reported based on photographs of additional specimens collected in Curaçao and Panama.

***Paguriscus robustus* Lemaitre, Felder & Poupin, 2017**

(Figs 8–10, 11A)

Paguriscus robustus Lemaitre, Felder & Poupin, 2017: 175, figs 16, 17, tab. 1; Poupin, 2018: 163.

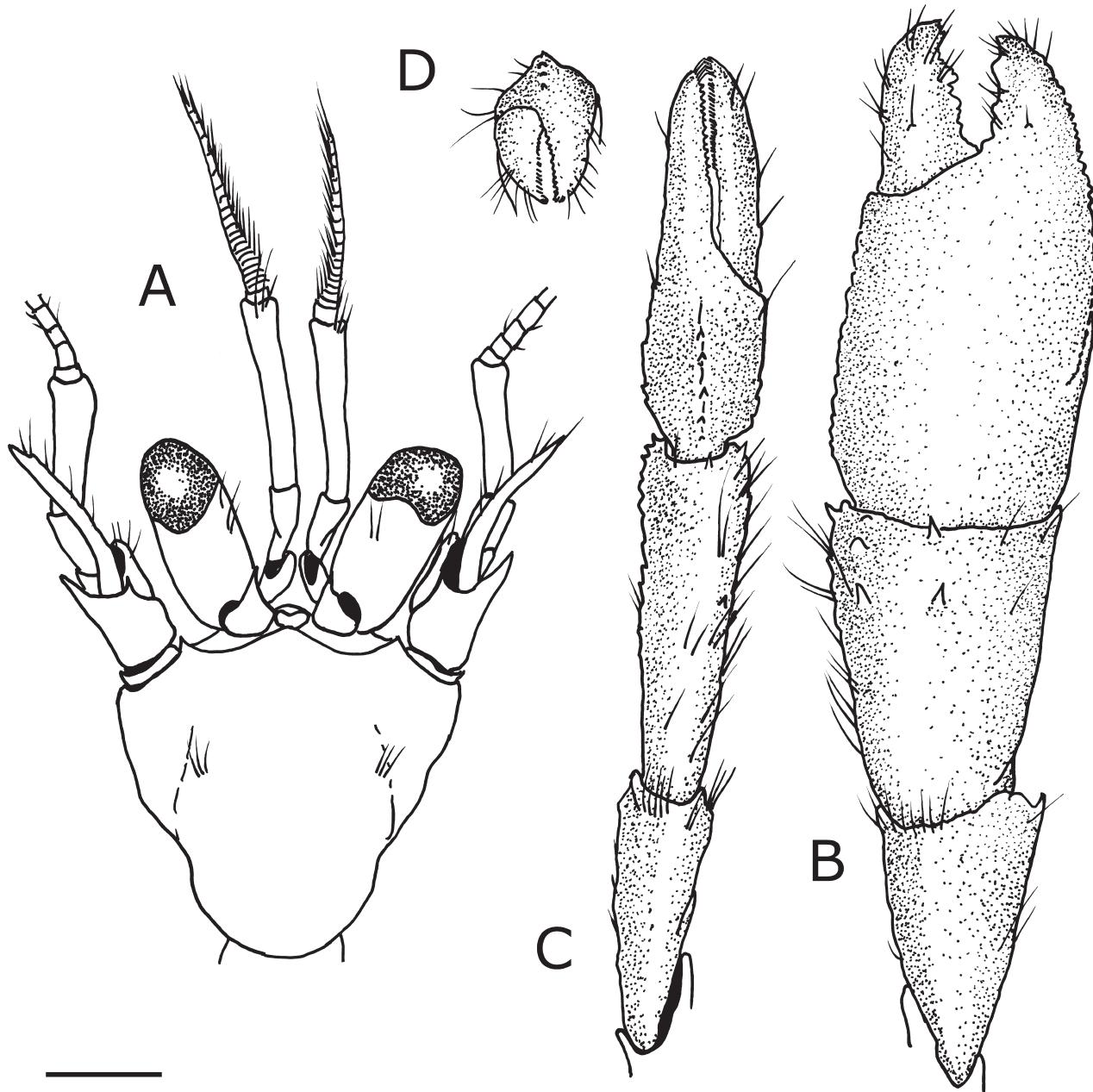


FIGURE 8. *Paguriscus robustus* Lemaitre, Felder & Poupin, 2017: male 1.3 mm, Bocas del Toro Province, Panama, Caribbean Sea (UF 044437): A, shield and cephalic appendages, dorsal; B, right cheliped, dorsal; C, left cheliped, dorsal; D, chela of same frontal. Scale: 0.5 mm.

Material examined. Bocas del Toro Province, Panama, Caribbean Sea: 19 males 0.7–1.2 mm, 5 females 0.7–1.0 mm, 16 ov females 0.9–1.3 mm, 12 specimens unsexed, unmeasured [in shells] runway, 9.342°N, 82.260°W, BBDT-1291, BCS2016-023, 4.0–4.5 m, lagoon fringing reef, *Agaricia* reef framework, 19 May 2016, colls M. Léray, F. Michonneau, R. Lasley (UF 044397); 5 males 0.9–1.3 mm, same locality, depth, date and colls as previous, BBDT-2085, BCS2016-034, 23 May 2016 (UF 044437); 1 ov female, 1.2 mm, Cayo Roldán, 9.215°N, 82.324°W, BBDT-0902, BCS2016-016, 1.5–2 m, lagoon fringing reef, *Agaricia* reef framework, 17 May 2016, colls M. Léray, F. Michonneau, R. Lasley (UF 044347); 1 male 1.4 mm, same locality and data as previous, BBDT-0904, BCS2016-016 (UF 044349).

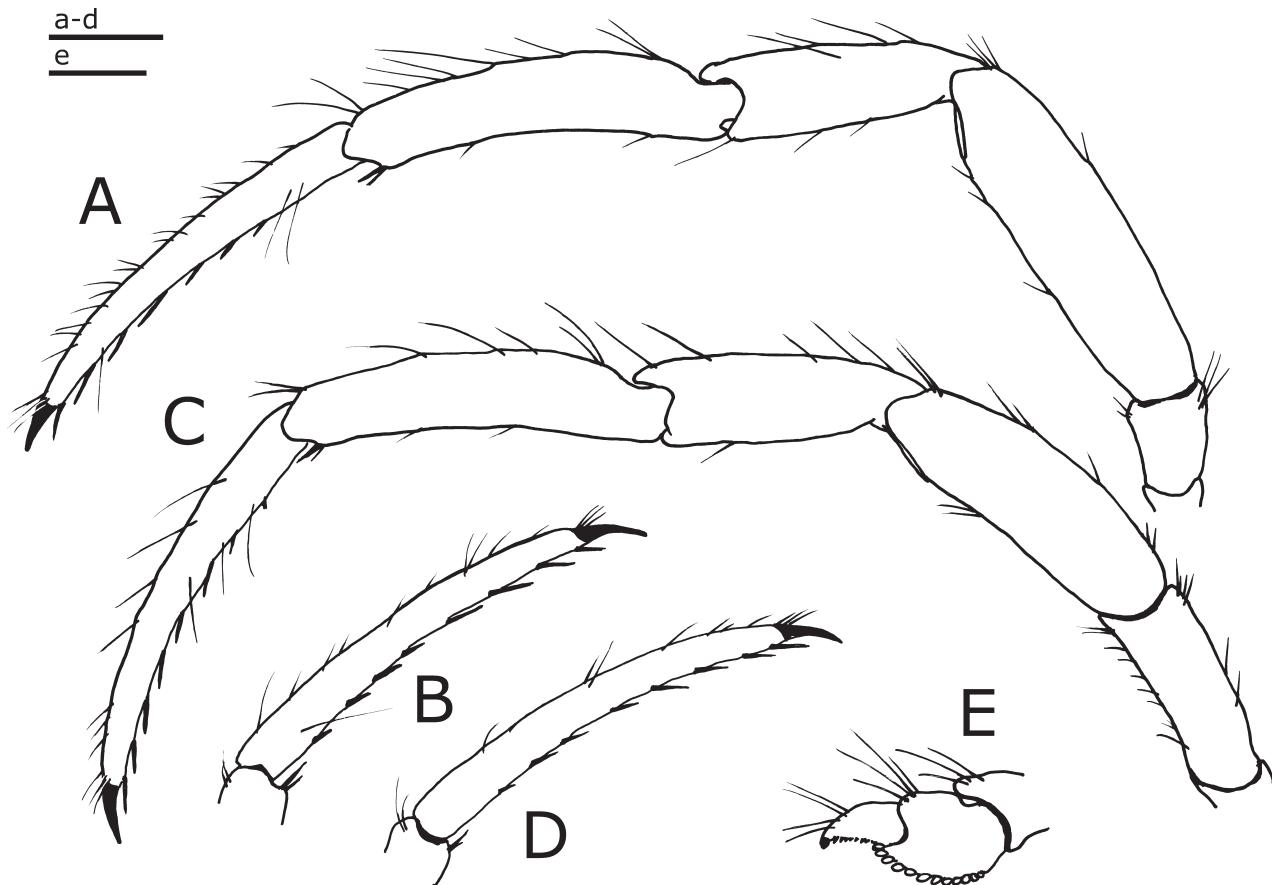


FIGURE 9. *Paguriscus robustus* Lemaitre, Felder & Poupin, 2017: male 1.3 mm, Bocas del Toro Province, Panama, Caribbean Sea (UF 044437): A, left pereopod 2, lateral; B, dactyl of same, mesial; C, left pereopod 3, lateral; D, dactyl of same, mesial; E, propodus and dactyl of left pereopod 4, lateral. Scales: 0.5 mm (A–D), 0.25 mm (E).

Recognition characters. Shield (Fig. 8A) glabrous, at most with scattered short setae, slightly longer than broad. Rostrum bluntly subtriangular, reaching distally to about same level of lateral projections. Lateral projections subtriangular, terminating in small sharp spine. Ocular peduncles short and stout, about 0.6 length of shield; corneas weakly dilated. Ocular acicles subtriangular, terminating in strong distal spine. Ultimate antennular segment with 2 long dorsodistal bristles. Antennal peduncle acicle exceeding distal margin of cornea by about 0.3 length of acicle, broadly curving outward and terminating in strong spine, unarmed mesially except for few short setae; flagellum with scattered short setae each less than 1 flagellar article in length. Chelipeds sparsely setose. Right chela (Fig. 8B) smooth, glabrous, lacking spines, mesial margin of palm, and dorsolateral margins of fixed finger and anterior half of palm weakly but distinctly delimited by a low, minutely denticulate ridge; carpus with 3 spines on dorsodistal margin. Palm of left cheliped (Fig. 8C, D) with median ridge-like elevation armed with few minute tubercles or spines. Pereopods 2 and 3 (Fig. 9A–D) with dactyls each armed with ventromesial row of 8–10 long, slender spinules; carpus with dorsodistal angle blunt. Anterior lobe of sternite XI (of pereopods 3; Fig. 10A, B) subsemicircular. Pereopod 4 with dactyl lacking preungual process; propodal rasp (Fig. 9E) with single row of rounded corneous scales. Sternite XIII (of pereopods 5) narrow (Fig. 10A, C), anterior lobe bilobed. Uropods (Fig. 10D) markedly asymmetrical, left largest. Telson (Fig. 10D) nearly symmetrical, longer than broad; terminal margins of posterior

lobes weakly oblique, each armed with 3 or 4 minute spines. Males with coxae of pereopods 5 extended posteriorly as paired, subequal, stout and calcified sexual tubes (Fig. 10C). Females with unpaired left gonopore (Fig. 10A); with left unpaired pleopods 2–5 (pleopod 5 not ovigerous), eggs relatively few (ranging 5–22) and large (maximum diameter approximately 0.4 mm).

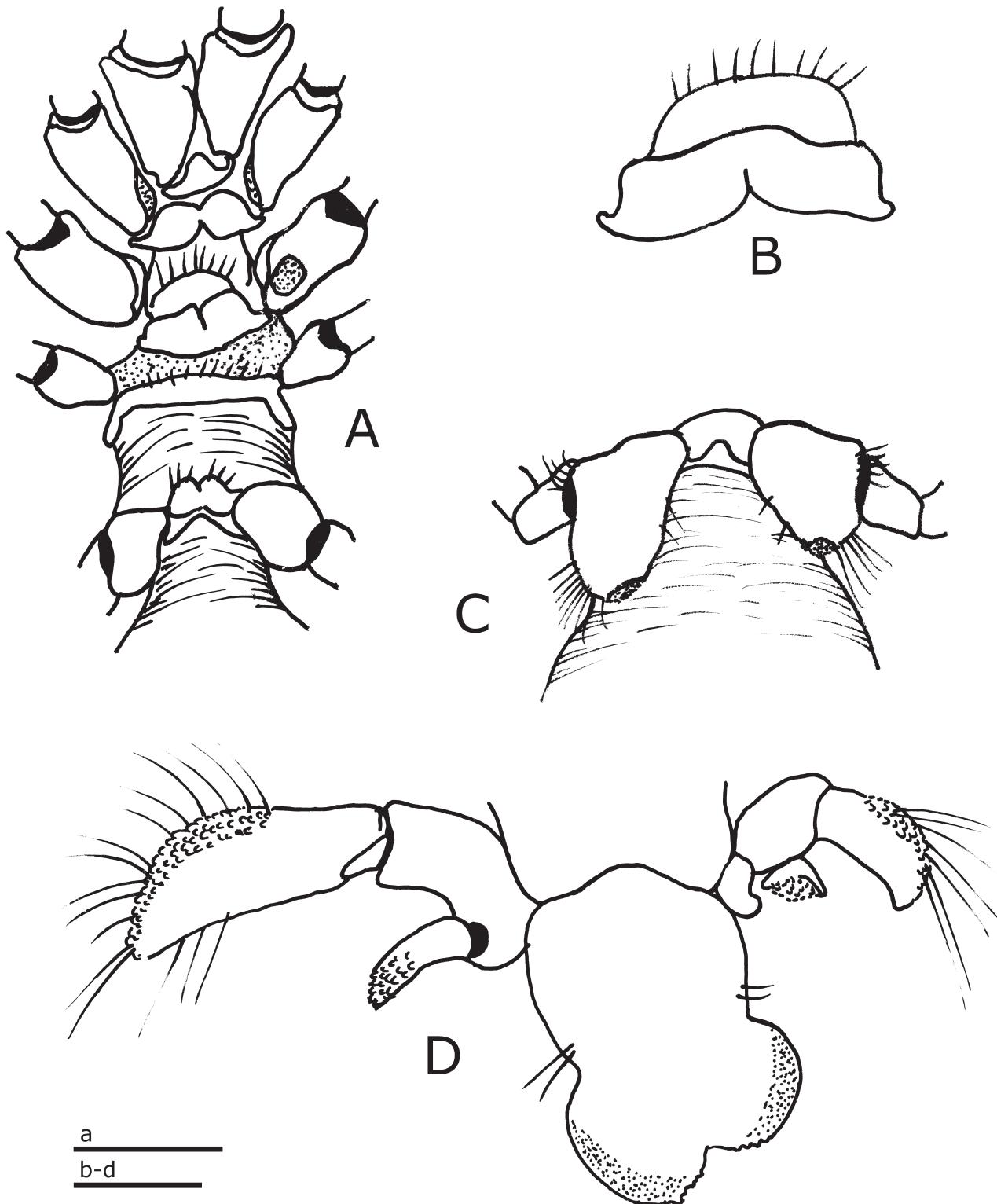


FIGURE 10. *Paguriscus robustus* Lemaitre, Felder & Poupin, 2017: male 1.3 mm, Bocas del Toro Province, Panama, Caribbean Sea (UF 044437): A, sternum and coxae of pereopods 1–5, ventral; B, anterior and posterior lobes of sternite XI of pereopods 3, ventral; C, sternite XIII of pereopod 5 with sexual tubes, ventral; D, uropods and telson, dorsal. Scales: 0.5 mm (A), 0.25 mm (B–D).

Color (Fig. 11A). Overall evenly semi-transparent light brownish except for white corneas, and whitish tone near articulation of segments in pereopods 2 and 3 (ambulatory legs).

Distribution. Caribbean Sea, from Guadeloupe, and Bocas del Toro Province, Panama. Depth: 1.5–19 m.

Remarks. Lemaitre *et al.*'s (2017 original description of the genus *Paguriscus* and its single species *P. robustus* was based exclusively on the incomplete male holotype missing the left cheliped and all other pereopods except the right cheliped and right pereopod 3. Thus, the generic diagnosis and species description was lacking in regard the morphology of the missing appendages and the characteristics of the female. Herein are reported numerous additional specimens of both sexes from Bocas del Toro, Panama, which have allowed to document the condition of the female as well as a complete documentation of the morphology and distribution of *P. robustus*. The new specimens also show that this species occurs broadly in the Caribbean, and is now known from the eastern (Guadeloupe) and western end (Bocas del Toro, Panama).

The presence of unpaired gonopores in females of *Paguriscus robustus* is yet another important character that justifies placing this species in a genus of its own, and thus is herein considered diagnostic of *Paguriscus*. Unpaired gonopores is a sexual character that appears to be unique among hermit crabs of the diverse family Paguridae, where species of at least 12 genera have this condition, and to all species of the deep-water family Parapaguridae, and is typically considered to be of generic level significance.

There is only a small degree of sexual dimorphism in *Paguriscus robustus*, with females having slightly shorter and less strong right chelipeds than in males. The left cheliped in both sexes is similar, with the palm (Fig. 8D) having a distinctly raised median ridge armed with minute spines. Females have unpaired left pleopods 2–5 (pleopod 5 not ovigerous), and when ovigerous carry relatively few, large eggs.

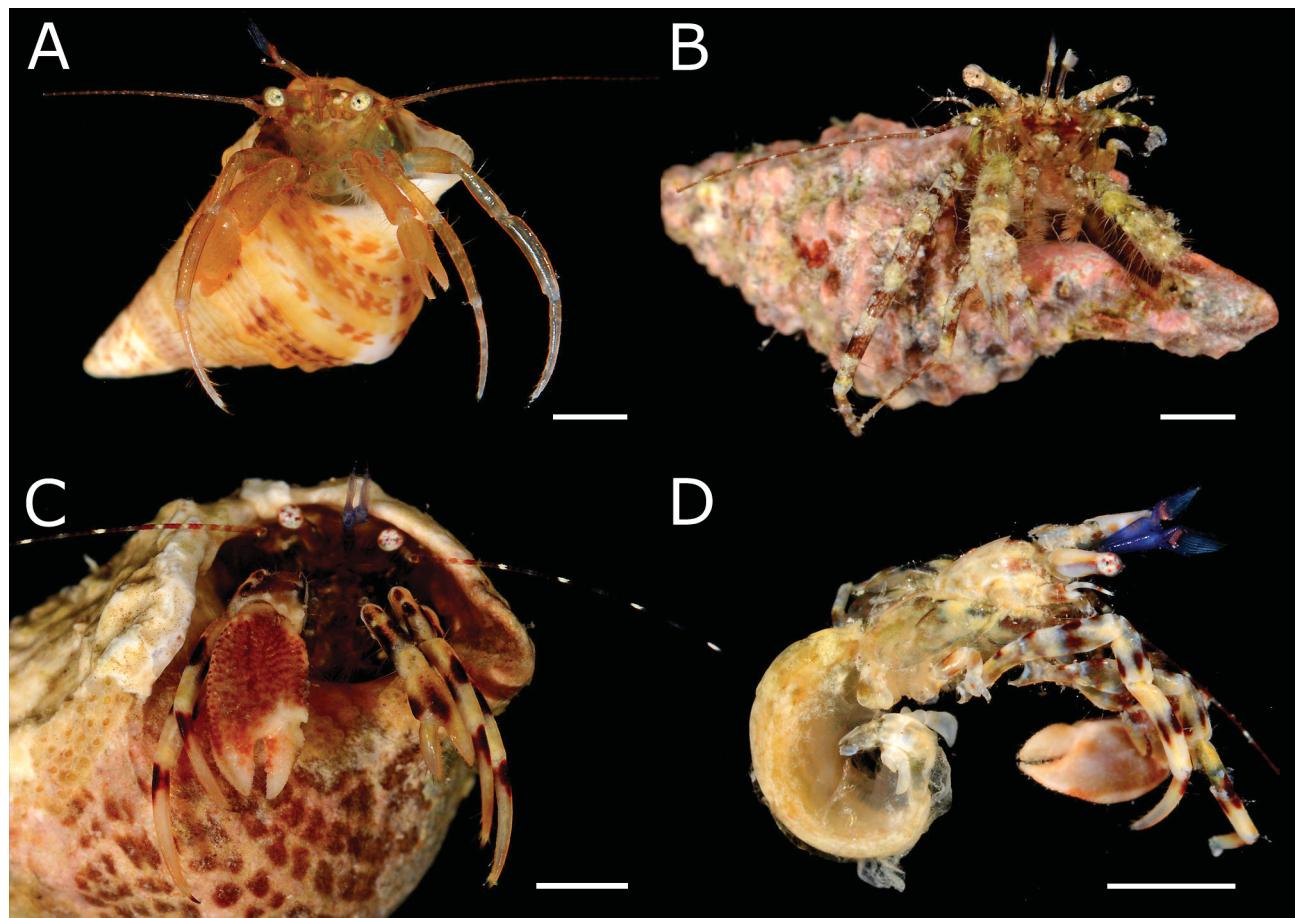


FIGURE 11. A, *Paguriscus robustus* Lemaitre, Felder & Poupin, 2017, Bocas del Toro Province, Panama, Caribbean Sea: male, 1.2 mm (UF 044397); B, *Nematopaguroides karukera* Lemaitre, Felder & Poupin, 2017, Bocas del Toro Province, Panama, Caribbean Sea: ov female in shell 1.8 mm (UF 044300); C, D, *Pylopaguridium markhami* McLaughlin & Lemaitre, 2001, Bocas del Toro Province, Panama, Caribbean Sea: C, male 1.6 mm (UF 044314); D, male 1.4 mm (UF 044396). Scales: 1.0 mm (A), 2.0 mm (B–D). (Photographs: G. Paulay)

Pagurus alarius sp. nov.

(Figs 12–14)

Type material. Holotype: female 1.5 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea, 9.289°N, 82.296°W, BBDT-2888, BCS2016-043, 3.0–3.5 m, lagoon fringing reef, *Agaricia* reef framework, 27 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 052162).

Description. Eleven pairs of biserial phyllobranch gills. Shield (Fig. 12A) approximately as long as broad; dorsal surface glabrous, lacking lineae or grooves except for weakly visible and short linea d, smooth except for few setae on linea d; lateral lobes obsolete. Anterolateral margins sloping. Anterior margins between rostrum and lateral projections weakly concave. Posterior margin truncate. Rostrum obtusely subtriangular, reaching slightly in advance of lateral projections, terminating in small spine. Lateral projections triangular, with small marginal spine. Posterior carapace membranous; anterior lobe of branchiostegite with setae on distal margin.

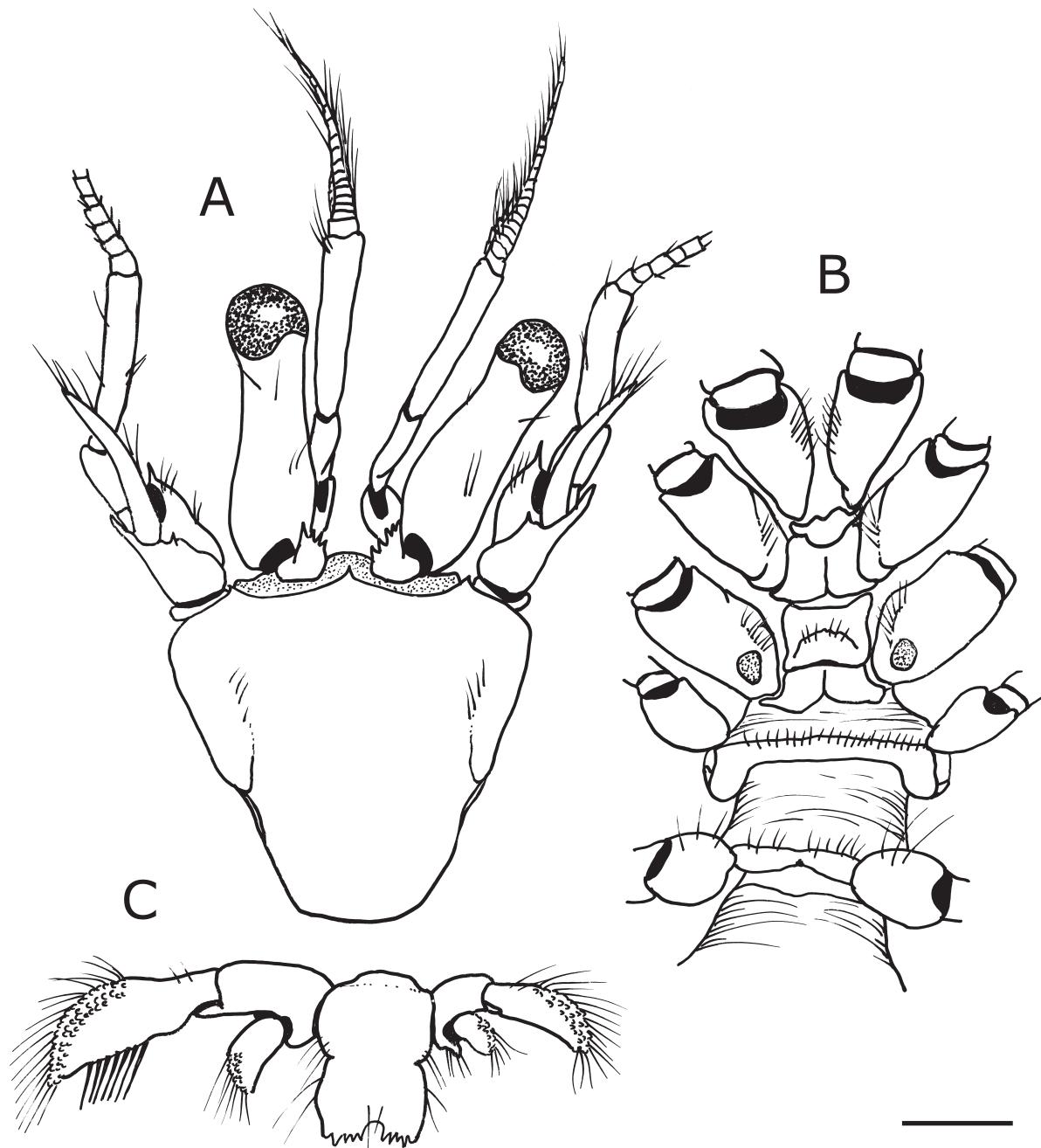


FIGURE 12. *Pagurus alarius* sp. nov., holotype female 1.5 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea (UF 052162): A, shield and cephalic appendages, dorsal; B, sternum and coxae of pereopods 1–5, ventral; C, uropods and telson, dorsal. Scale: 0.5 mm.

Ocular peduncles long, approximately 0.8 length of shield (including corneas), slightly inflated basally, with few scattered short setae; corneas weakly dilated. Ocular acicles subtriangular, terminating in multifid margin of 4 or 5 spines, separated by approximately basal width of 1 acicle.

Antennular peduncle exceeding distal margin of corneas by approximately one-third of ultimate segment when fully extended. Ultimate segment naked except for dorsodistal tuft of setae. Penultimate and basal segments glabrous. Basal segment with small spine on dorsolateral distal margin.

Antennal peduncle exceeding distal margin of corneas by approximately one-half length of fifth segment. Fifth and fourth segments unarmed except for scattered setae. Third segment with strong spine and tuft of setae on ventrodistal margin. Second segment with dorsolateral distal angle produced into strong acute projection terminating in spine; dorsomesial distal angle with small sharp spine, and short setae on mesial surface; first segment unarmed. Antennal acicle reaching to approximately distal margin of cornea, broadly curved outward, terminating in acute spine with tufts of setae; mesial margin with row of long setae. Flagellum long, distinctly overreaching right cheliped; with short setae less than 1 article in length.

Mouthparts not dissected. Third maxilliped ischium with weak crista dentata consisting of row of about 15 minute teeth slightly increasing in size proximally, and strong accessory tooth.

Chelipeds unequal, right longer and distinctly stronger than left. Right cheliped (Fig. 13A–C) somewhat compressed dorsoventrally; dactyl and fixed finger leaving narrow hiatus proximally when closed, slightly crossed distally at tips when closed, each terminating in small, blunt corneous claw, cutting edges each with row of small, rounded, calcareous teeth slightly increasing in size distally. Dactyl slightly shorter than palm (measured on mesial margin), dorsal surface naked, with row of small tubercles along weakly elevated midline, and row of mesially directed setae near cutting edge; mesial margin armed on proximal half with strong spines and long setae; ventral surface naked. Fixed finger with scattered small tubercles on dorsal surface; lateral margin with row of strong spines and long setae; ventral surface naked. Palm approximately as long as carpus; dorsal surface nearly naked, with scattered small blunt tubercles or minute spines, median region slightly elevated; lateral and mesial margins armed with strong spines and fringe of long setae directed slightly upwards; ventral surface naked. Carpus approximately as long as merus, with few long setae on dorsal surface; dorsolateral surface rounded, with irregular row of 5 spines; dorsodistal margin with 2 median spines; dorsomesial margin with 3 spines on distal half; ventral surface unarmed except for a few setae. Merus subtriangular; dorsal surface naked; lateral surface smooth, ventrolateral distal margin with 3 spines; mesial surface smooth, ventromesial distal margin with 1 spine; ventral surface glabrous. Ischium and coxa glabrous, latter with few short setae on ventromesial margin.

Left cheliped (Fig. 13D, E) with fingers leaving narrow hiatus when closed, terminating in small corneous claws crossed when closed. Dactyl approximately as long as palm, surfaces with scattered short setae; cutting edge with row of fused corneous teeth on distal half; dorsal and ventral surfaces unarmed except for scattered setae and few minute tubercles; lateral surface rounded. Fixed finger with scattered minute tubercles and few tufts of short setae on dorsal surface; cutting edge with small, well-spaced calcareous teeth and row of fused corneous teeth on distal one-third; lateral margin with row of small spines on proximal half. Palm approximately half as long as carpus; dorsal surface with scattered short setae, with 2 rows of small spines medially; lateral margin with row of small spines; mesial surface rounded; ventral surface glabrous. Carpus as long as merus; armed with row of spines on dorsolateral and dorsomesial margins, and strong dorsodistal spine; lateral and mesial surfaces smooth, with scattered tufts of setae; ventral surface glabrous. Merus subtriangular, naked; dorsal and dorsodistal margins unarmed; ventrolateral margin with row of 5 spines increasing in length distally; ventromesial margin with 1 distal spine; ventral surface with few long setae. Ischium and coxa unarmed, latter with short setae on ventromesial margin.

Pereopods 2 and 3 (Fig. 14A–D) similar from left to right, except for slightly slenderer and longer segments of left pereopods; dactyls broadly curved distally, each terminating in sharp corneous claw. Dactyl slightly shorter than propodus; dorsal margin with long setae; ventromesial margin with 7 or 8 distinct corneous spinules, and few long setae. Propodus glabrous except for few long setae on dorsal and ventral margins. Carpus with small dorsodistal spine, otherwise unarmed except for few long setae dorsally and ventrally. Merus and ischium glabrous except for few setae dorsally and ventrally. Coxa glabrous except for short setae on ventromesial margin. Sternite XI (of pereopods 3), with anterior lobe (Fig. 11B) semi-subcircular, sparsely setose and armed with small spine on distal margin.

Pereopod 4 (Fig. 14E) semichelate. Dactyl broadly curved, slender, subtriangular, terminating in a sharp corneous claw, with ventrolateral row of minute, fused corneous teeth; dorsal margin nearly naked. Propodus with few

setae on dorsodistal angle; propodal rasp consisting of 2 rows of ovate corneous scales, no preungual process. Carpus with sparse long setae on dorsal margin and ventrodistal angle. Merus nearly naked except for few long setae on ventral margin. Ischium with few setae on ventromesial margin.

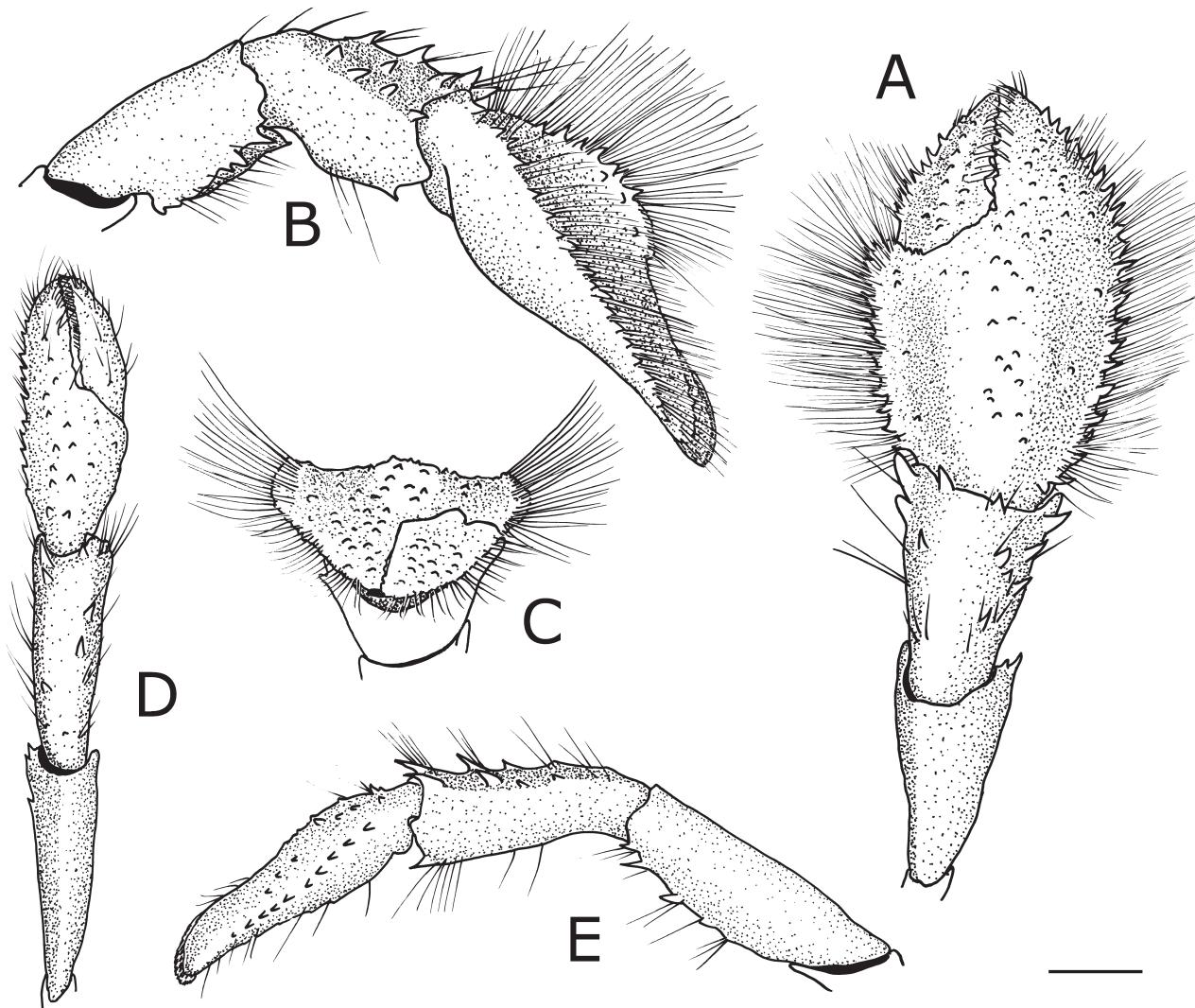


FIGURE 13. *Pagurus alarius* sp. nov., holotype female 1.5 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea (UF 052162): A, right cheliped, dorsal; B, same, lateral; C, chela of same, frontal; D, left cheliped, dorsal; E, same, lateral. Scale: 0.5 mm.

Pereopod 5 chelate. Dactyl with long setae on dorsodistal margin. Propodus with row of long setae on ventral surface; propodal rasp occupying approximately one-third of lateral face of propodus. Carpus, merus, and ischium naked or with scattered short setae. Sternite XIII (of pereopods 5; Fig. 12B), narrow, weakly subdivided into 2 slightly asymmetric narrow lobes, with few setae on distal margin.

Uropods (Fig. 12C) strongly asymmetrical; left uropod largest, with fringe of long bristle-like setae on posterior margin. Telson (Fig. 12C) nearly symmetrical, with transverse suture; anterior lobes with few setae laterally; posterior lobes separated by deep U-shaped median cleft, with few setae laterally, terminal margins nearly horizontal, each armed with 5 strong blunt or sharp calcareous spines.

Male unknown. Female with paired gonopores; lacking first pleopods, with unpaired left pleopods 2–5.

Color. Unknown.

Etymology. The specific name is derived from the Latin *alarius*, meaning of wings, and refers to the wing-like similarity of the fringes of long setae on the right chela that characterize this new species.

Distribution. Caribbean Sea, known so far only from Bocas del Toro Province, Panama. Depth: 3.0–3.5 m.

Remarks. This new species, known exclusively from the female holotype, is assigned for the time being to *Pagurus*, a catch-all genus for any pagurid with 11 pairs of phyllobranchiate gills and lacking any secondary sexual

modifications or similar exclusive characters. Future discovery of males of this new species and their sexual characteristics may require a generic reevaluation of this taxon.

Pagurus alarius sp. nov. is distinct from other species assigned to *Pagurus* from the western Atlantic most notably by the armature and setation pattern of the right chela (Fig. 13A–C) which has on the lateral and mesial margins a fringe of long setae directed obliquely upwards in wing-like fashion. In that character alone, and combined with the presence of a row of bristle-like setae on the posterior margin of the exopod of the left uropod, there is no obvious affinity with other known western Atlantic congeners.

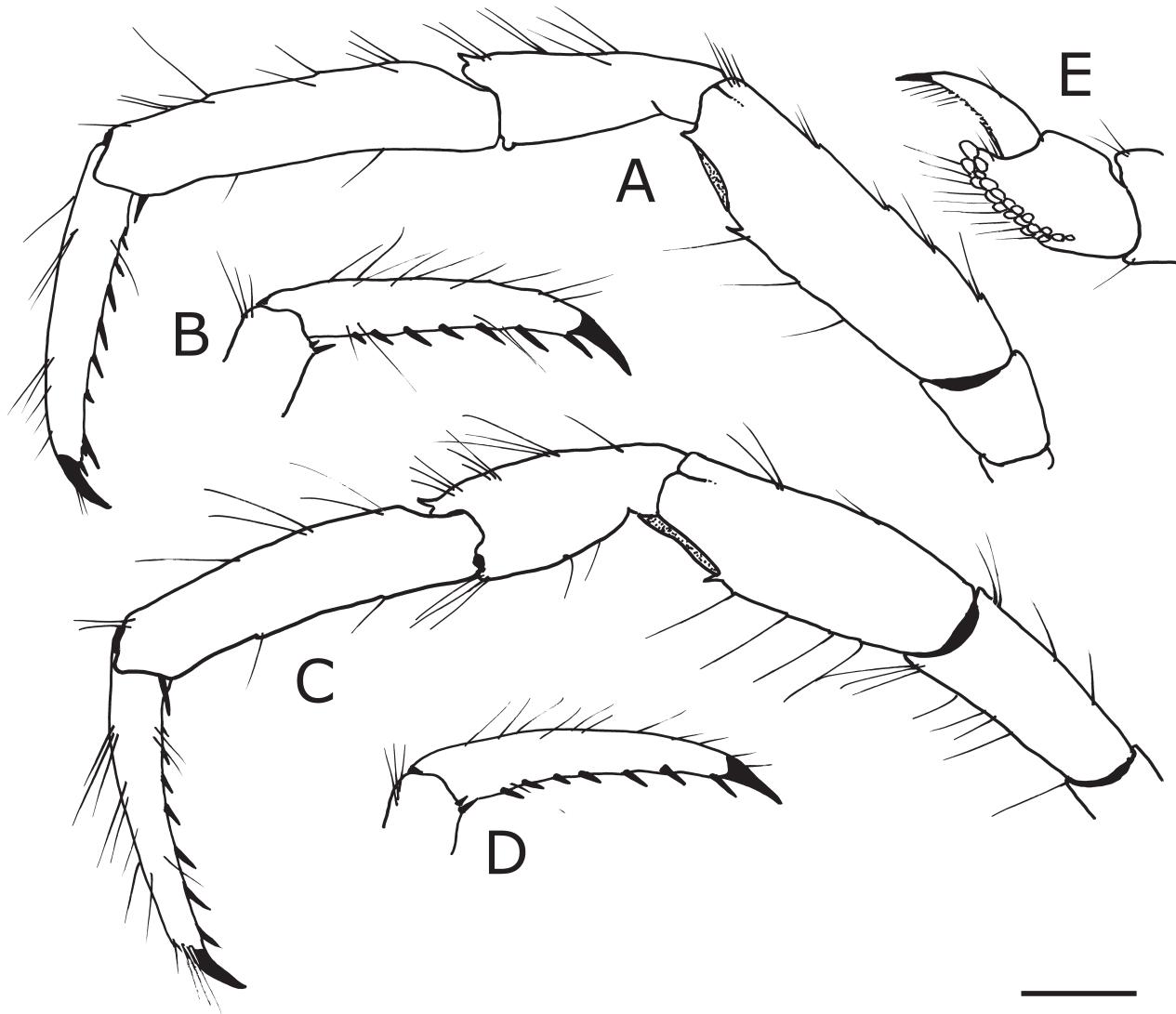


FIGURE 14. *Pagurus alarius sp. nov.*, Holotype female 1.5 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea (UF 052162): A, left pereopod 2, lateral; B, dactyl of same, mesial; C, left pereopod 3, lateral; D, dactyl of same, mesial; E, propodus and dactyl of left pereopod 4, lateral. Scale: 0.5 mm.

Pylopaguridium markhami McLaughlin & Lemaitre, 2001

(Figs. 11C, D, 15–17)

Pylopaguridium markhami McLaughlin & Lemaitre, 2001: 472, figs 14c, d, 15, 16; Lemaitre & McLaughlin, 2003: 467; McLaughlin *et al.* 2010: 35.

Material examined. Bocas del Toro Province, Panama, Caribbean Sea: 1 male 1.6 mm, Punta Puebla, 9.367°N, 82.291°W, BBDT-0608, BCS2016-012, 4–4.5 m, lagoon fringing reef, *Agaricia* reef framework, 16 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044314); 1 female 1.0 mm, 1 imm sex indet 0.9 mm, runway,

9.342°N, 82.260°W, BBDT-2089, BCS2016-034, 4–4.5 m, lagoon fringing reef, *Agaricia* reef framework, 23 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044399); 1 male 1.4 mm, same station data as previous, BBDT-1279, BCS2016-023 (UF 044396); 8 males 1.3–2.2 mm, 3 females 1.6–2.1 mm, 3 ov females 1.4–2.1 mm, Seagal, 9.289°N, 82.296°W, BBDT-2888, BCS2016-043, 3–3.5 m, lagoon fringing reef, *Agaricia* reef framework, 27 May 2016, colls M. Leray, F. Michonneau, R. Lasley (UF 044528).

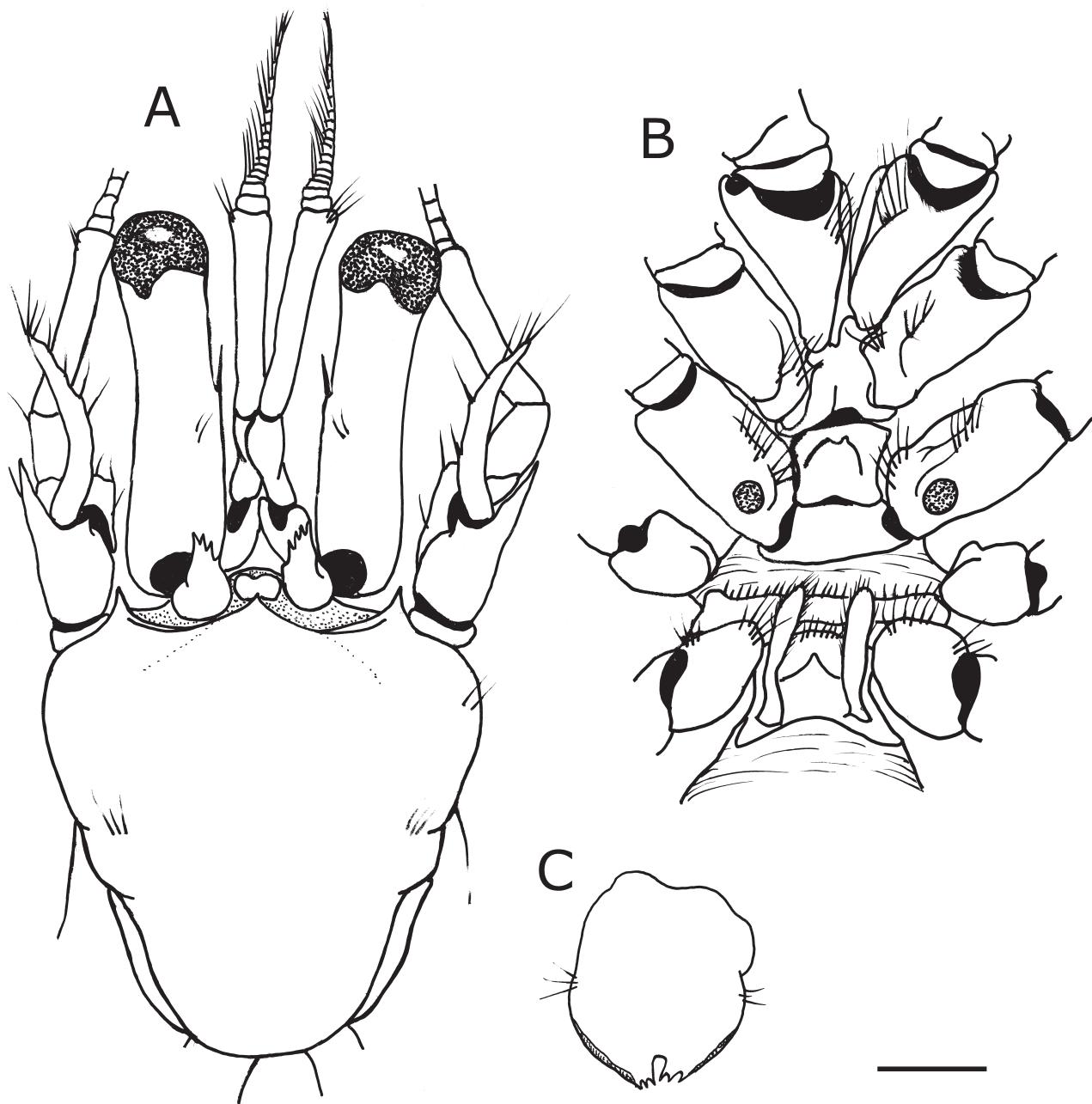


FIGURE 15. *Pylopaguridium markhami* McLaughlin & Lemaitre, 2001, female 2.1 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea (UF 044528): A, shield and cephalic appendages, dorsal; B, sternum and coxae of pereopods 1–5, ventral; C, telson, dorsal. Scale: 0.5 mm.

Recognition characters. Shield (Fig. 15A) slightly to distinctly longer than broad; lateral projections prominent, acutely subtriangular, reaching beyond level of tip of rostrum, terminating in sharp marginal or submarginal spine. Rostrum obtusely subtriangular, terminating in sharp spine. Ocular peduncles moderately long and slender, approximately 0.8 as long as shield, each with median bristle-like seta on mesial surface; corneas weakly dilated. Ocular acicles multifid, each terminating in 4 or 5 slender spines. Antennular and antennal peduncles reaching to distal margin of corneas; antennal acicles curving outwards, terminating in strong spine, with few setae mesially. Chelipeds nearly similar in length but distinctly dissimilar in strength and spination; right (Fig. 16A, B) approxi-

mately twice as wide as left, sparsely setose, chela with numerous blunt spines or tubercles on dorsal surface, carpus with dorsolateral and dorsomesial row of spines; left (Fig. 16C, D) sparsely setose, chela with scattered small tubercles on dorsal surface, carpus with dorsal row of well-spaced spines. Pereopods 2 and 3 (Fig. 17A–D) similar from left to right; sparsely setose, lacking spines except for ventromesial row of 7 or 8 corneous spinules increasing in size distally on each dactyl. Pereopod 4 (Fig. 16E) lacking preungual process on dactyl; propodal rasp (Fig. 17E) with 1 row of ovate scales. Anterior lobe of sternite XI (of pereopods 3; Fig. 15B) rounded, armed with 1 or 2 small spines anteriorly. Uropods strongly asymmetrical, left largest. Telson (Fig. 15C) nearly symmetrical, longer than broad, with distinct lateral indentations; posterior lobes separated by deep U-shaped median cleft, posterior margins nearly straight or slightly oblique, each armed with 3 or 4 spines.

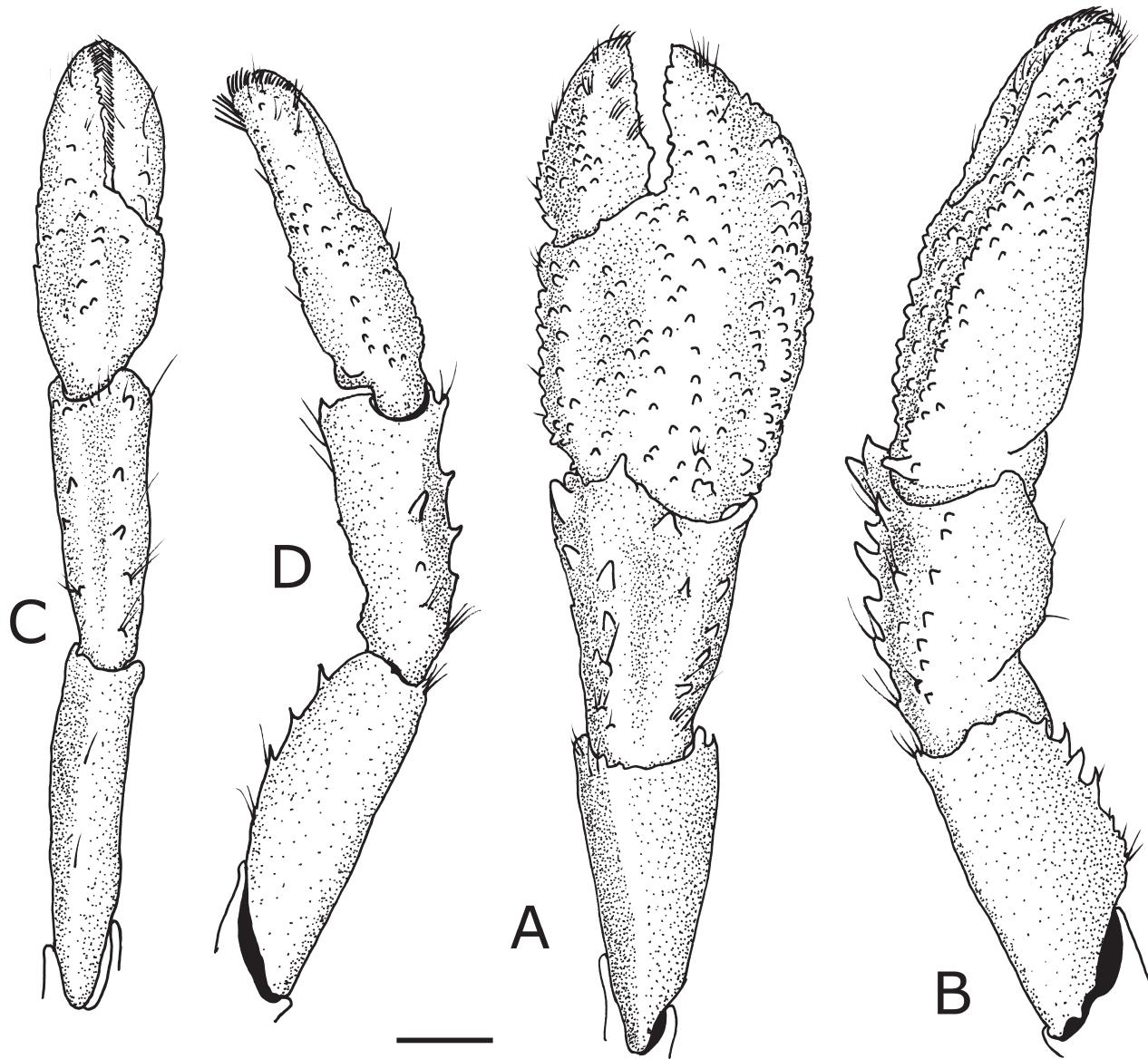


FIGURE 16. *Pylopaguridium markhami* McLaughlin & Lemaitre, 2001, female 2.1 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea (UF 044528): A, right cheliped, dorsal; B, same, lateral; C, left cheliped, dorsal; D, same lateral. Scale: 0.5 mm.

Color (Fig. 11C, D). Shield mostly cream-white with somewhat darker portions laterally, and light brown region one each side of anterior half. Ocular peduncles cream-white dorsally, faded purple ventrally; cornea white with reddish spots. Antennular peduncles blue; upper flagella reddish ventral portion. Antennal peduncles cream-white in background, with second segment having brownish portions laterally and mesially, acicle with distal brownish band; flagella dark brown with approximately 8 short white bands. Right chela with dactyl and fixed finger white with brownish teeth, palm with faded to brownish spines over whitish background. Left cheliped white, palm with dark

brown region distomedially and distomesially; carpus and merus brown with lateral and mesial faces mostly brown. Pereopods 2 and 3 (ambulatory legs) white with short dark brown stripes as follows; 1 dorsomedially on basal portion of dactyl, and 3 medially on dorsal, lateral and mesial faces of merus, carpus and propodus.

Distribution. Caribbean Sea, from the Turk and Caicos Islands in the Bahamas, off eastern Honduras, and now Bocas del Toro, Panama. Depth: 3–36 m.

Remarks. This species is included in the “*Pylopagurus-Tomopagurus*” group, and prior to this study, was known exclusively from the specimens used in the original description by McLaughlin & Lemaitre (2001) from the Bahamas and off eastern Honduras. Subsequently, this species was listed in a taxonomic summary of the “*Pylopagurus-Tomopagurus*” group of genera and species (Lemaitre & McLaughlin 2003), and in a checklist of the Paguroidea of the world (McLaughlin *et al.* 2010). The presence of *Pylopaguridium markhami* in Bocas del Toro, Panama, in the southwestern Caribbean Sea, amplifies even more its distribution in the West Indian region.

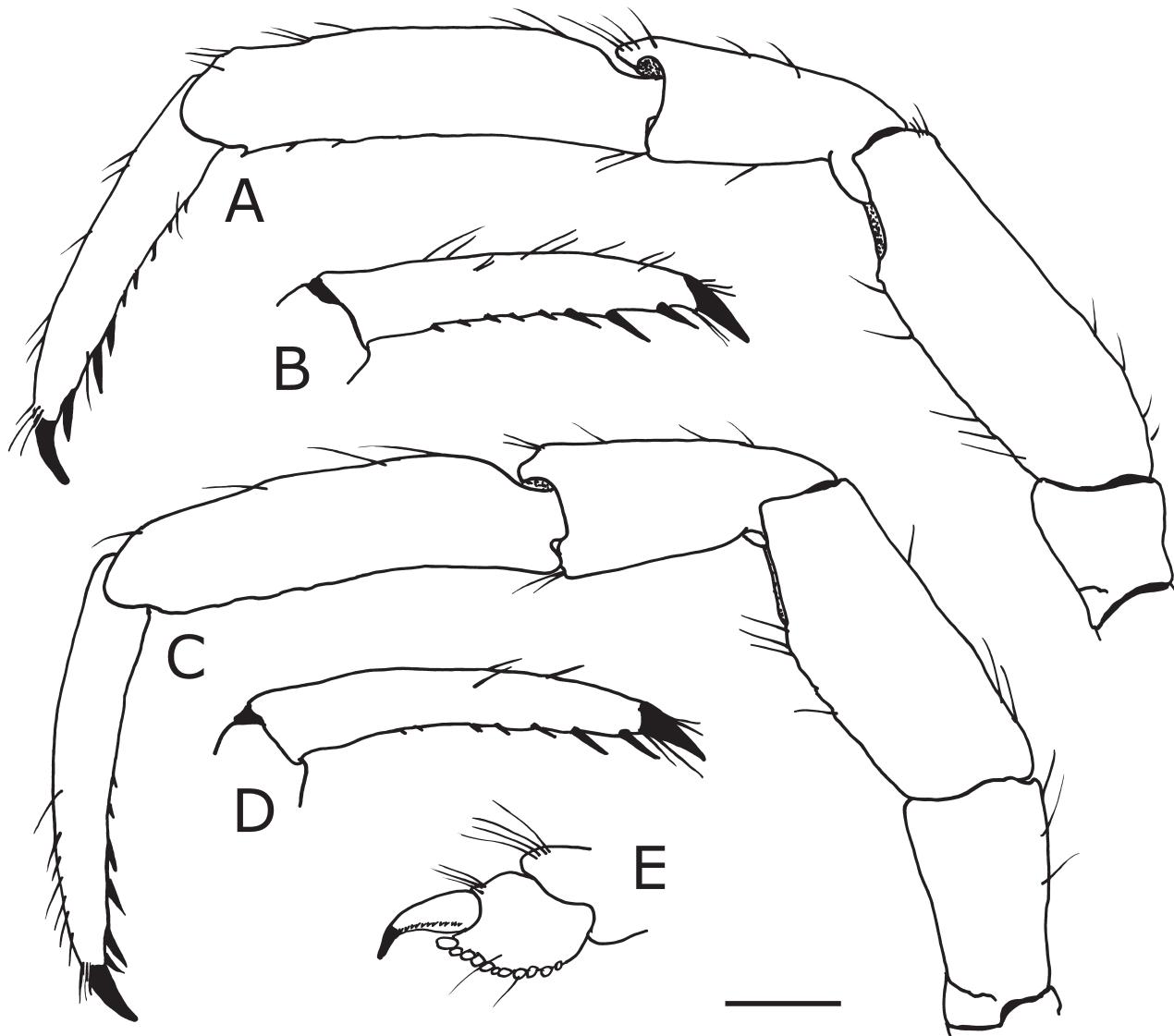


FIGURE 17. *Pylopaguridium markhami* McLaughlin & Lemaitre, 2001, female 2.1 mm, Seagal, Bocas del Toro Province, Panama, Caribbean Sea (UF 044528): A, left pereopod 2, lateral; B, dactyl of same, mesial; C, left pereopod 3, lateral; D, dactyl of same, mesial; E, propodus and dactyl of left pereopod 4, lateral. Scale: 0.5 mm.

The original description of *Pylopaguridium markhami* included partial and somewhat unfocused photographs of the dorsal aspect of the left and right cheliped of a female, illustrations of various body parts of a male, and sternite XIII and first gonopods of a female (McLaughlin & Lemaitre 2001: figs. 14c, d, 15). Herein are included illustrations of a female (shield length = 2.1 mm, UF 044528) from Bocas del Toro, Panama, showing all diagnostic aspects with more complete details and views.

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References

Baker, J.H., Jobe, W.D., Howard, C.L., Kimball, K.T., Janousek, J. & Case, P.R. (1981) Benthic biology. In: Bedinger, C.A.Jr. (Ed.), *Ecological Investigations of Petroleum Production Platforms in the Central Gulf of Mexico*. Vol. 1. Part 6. Southwest Research Institute, Houston, Texas, pp. 1–391.

Baldwin, C.C., Tornabene, L. & Robertson, D.R. (2018) Below the Mesophotic. *Scientific Reports*, 8 (1), 4920. <https://doi.org/10.1038/s41598-018-23067-1>

Coelho, P.A. & Ramos, M. de A. (1973) A constituição e a distribuição da fauna de decápodos do litoral leste da América do Sul entre as latitudes 5° N e 39° S. *Trabalhos Oceanográficos da Universidade Federal de Pernambuco, Recife*, 13, 133–236. [1972] <https://doi.org/10.5914/tropocean.v13i1.2555>

Coelho, P.A. & Ramos-Porto, M. (1986) Sinopse dos crustáceos decápodos brasileiros (famílias Callianassidae, Callianideidae, Upogebiidae, Parapaguridae, Paguridae, Diogenidae). *Trabalhos Oceanográficos da Universidade Federal de Pernambuco, Recife*, 19, 27–53. [dated 1985, published 1986] <https://doi.org/10.5914/tropocean.v19i1.2615>

Coelho, P.A. & Santos, M.F.B.A. dos (1980) Zoogeografia marinha do Brasil. I. Considerações gerais sobre o método e aplicação a um grupo de crustáceos (Paguros: Crustácea Decápoda, super-famílias Paguroidea e Coenobitoidea). *Boletim do Instituto Oceanográfico, São Paulo*, 29 (2), 139–144. <https://doi.org/10.1590/S0373-55241980000200029>

Coelho, P.A., Oliveira de Almeida, A., Arruda Bezerra, L.E. & Souza-Filho, J.F. de (2007) An updated checklist of decapod crustaceans (infraorders Astacidea, Thalassinidea, Polychelida, Palinura, and Anomura) from the northern and northeastern Brazilian coast. *Zootaxa*, 1519 (1), 1–16. <https://doi.org/10.11646/zootaxa.1519.1.1>

Felder, D.L., Álvarez, F., Goy, J.W. & Lemaitre, R. (2009) Decapoda (Crustacea) of the Gulf of Mexico, with comments on the Amphionidacea. In: Felder, D.L. & Camp, D.K. (Eds.), *Gulf of Mexico Origin, Waters, and Biota. Vol. 1. Biodiversity*. Texas A&M University Press, College Station, Texas, pp. 1019–1104.

Forest, J. & Saint Laurent, M. de (1968) Résultats scientifiques des campagnes de la "Calypso", Part 7. Campagne de la Calypso au large des côtes Atlantiques de l'Amérique du Sud (1961–1962). 6. Crustacés Décapodes: Pagurides. *Annales de l'Institut Océanographique de Monaco*, New Series, 45 (2), 45–172. [1967]

Gore, R.H. (1981) Three new shrimps, and some interesting new records of decapod Crustacea from a deep-water coral reef in the Florida Keys. *Proceedings of the Biological Society of Washington*, 94 (1), 135–162.

Latreille, P.A. (1802) *Histoire naturelle, générale et particulière, des Crustacés et des Insectes*. Vol. 3. F. Dufart, Paris, 467 pp.

Lemaitre, R. & McLaughlin, P.A. (2003) Revision of *Pylopagurus* and *Tomopagurus* (Crustacea: Decapoda: Paguridae) with descriptions of new genera and species. Addendum and taxonomic summary. *Proceedings of the Biological Society of Washington*, 116 (2), 464–486.

Lemaitre, R. & Tavares, M. (2015) New taxonomic and distributional information on hermit crabs (Crustacea: Anomura: Paguroidea) from the Gulf of Mexico, Caribbean Sea, and Atlantic coast of South America. *Zootaxa*, 3994 (4), 451–506.
<https://doi.org/10.11646/zootaxa.3994.4.1>

Lemaitre, R., Felder, D.L. & Poupin, J. (2017) Discovery of a new micro-pagurid fauna (Crustacea: Decapoda: Paguridae) in the Lesser Antilles, Caribbean Sea. *Zoosystema*, 39 (2), 151–195.
<https://doi.org/10.5252/z2017n2a1>

Lemaitre, R., McLaughlin, P.A. & Garcia-Gomez, J. (1982) The *Provenzanoi* group of hermit crabs (Crustacea, Decapoda, Paguridae) in the western Atlantic. Part 4. A review of the group, with notes on variations and abnormalities. *Bulletin of Marine Science*, 32 (3), 670–701.

Leray, M. & Knowlton, N. (2015) DNA barcoding and metabarcoding of standardized samples reveal patterns of marine benthic diversity. *Proceedings of the National Academy of Sciences of the United States of America*, 112 (7), 2076–2081.
<https://doi.org/10.1073/pnas.1424997112>

McLaughlin, P.A. (1981) Revision of *Pylopagurus* and *Tomopagurus* (Crustacea: Decapoda: Paguridae), with the descriptions of new genera and species: Part 2. *Rhodochirus* McLaughlin and *Phimochirus* McLaughlin. *Bulletin of Marine Science*, 31 (2), 329–365.

McLaughlin, P.A. (2003) Illustrated keys to families and genera of the superfamily Paguroidea (Crustacea: Decapoda: Anomura), with diagnosis of genera of Paguridae. *Memoirs of Museum Victoria*, 60 (1), 111–144.
<https://doi.org/10.24199/j.mmv.2003.60.16>

McLaughlin, P.A. & Lemaitre, R. (2001) Revision of *Pylopagurus* and *Tomopagurus* (Crustacea: Decapoda: Paguridae), with descriptions of new genera and species. Part 6. *Pylopagurus* Milne-Edwards and Bouvier, *Haigia* McLaughlin, and *Pylopaguridium* new genus. *Proceedings of the Biological Society of Washington*, 114 (2), 444–483.

McLaughlin, P.A., Komai, T., Lemaitre, R. & Rahayu, D.L. (2010) Annotated checklist of anomuran decapod crustaceans of the world (exclusive of the Kiwaoidea and families Chirostylidae and Galatheidae of the Galatheoidea) Part I—Lithodoidea, Lomisoidea and Paguroidea. *Raffles Bulletin of Zoology*, Supplement 23, 5–107.

Milne-Edwards, A. & Bouvier, E.-L. (1893) Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78), in the Caribbean Sea (1878–79), and along the Atlantic coast of the United States (1880), by the U.S. Coast Survey Steamer “Blake”, Lieut.-Commander C. D Sigsbee, U.S.N., and Commander J. R. Bartlett, U.S.N., commanding. 23. Description des Crustacés de la famille des paguriens recueillis pendant l’expédition. *Memoirs of the Museum of Comparative Zoology, Harvard College*, 14 (3), 5–172.

Poupin, J. (2018) *Les Crustacés décapodes des Petites Antilles. Avec de nouvelles observations pour Saint-Martin, la Guadeloupe et la Martinique*. Patrimoines Naturels 77. Muséum national d’Histoire naturelle, Paris, 264 pp.

Poupin, J. & Corbari, L. (2016) A preliminary assessment of the deep-sea Decapoda collected during the KARUBENTHOS 2015 Expedition to Guadeloupe Island. *Zootaxa*, 4190 (1), 1–107.
<https://doi.org/10.11646/zootaxa.4190.1.1>

Rieger, P.J. (1998) Malacostraca—Eucarida, Paguroidea. In: Young, P.S. (Ed.), *Catalogue of Crustacea of Brazil. Série Livros 6*. Museu Nacional, Rio de Janeiro, pp. 413–429.

Wang, Y.-L. & McLaughlin, P.A. (2000) First report of *Nematopaguroides* (Crustacea: Decapoda: Paguridae) in the IndoPacific, and description of a new species. *Proceedings of the Biological Society of Washington*, 113 (4), 956–963.